# Resource inventory of
# North Cameroon, Africa



*United States Department of Agriculture, Soil Conservation Service*
*and Fonds d'Aide et de Coopération, France*
*in cooperation with*
*United States Department of State, Agency for International Development*

## Preface

In 1974, the Government of the United Republic of Cameroon (GURC) requested the United States Agency for International Development (USAID) and the Fonds d'Aide et de Cooperation of France (FAC) to assist in developing the livestock subsector in North Cameroon. After consultation in Cameroon, USAID and FAC representatives indicated that the two agencies would favor providing such assistance if a study of alternative allocations of resources in North Cameroon indicated that such a project was desirable. The Government of the United Republic of Cameroon responded with a request for joint assistance in making an inventory of the total resources of North Cameroon.

This report describes the resource base and discusses planning for the use and management of the resources.

Cover: Part of a mountain chain near Poli in the South Benoue area. Savannah plant communities in such an area produce much forage but tsetse fly control and development of water supplies are needed for the best use of the area.

Contents

## Abbreviations Used in This Report

BDPA--Bureau pour le Developpement de la Production Agricole
BIRD--Banque Internationale pour la Reconstruction et le Developpement
BRGM--Bureau du Recherches Geologiques et Minieres
CBLT--Commission du Bassin du Lac Tchad
CFA--Communaute Financiere Africain (currency: 50 FCFA=1 French franc)
CFDT--Compagnie Francaise pour le Developpement des Fibres et Textiles
ERTS--Earth Resources Technology Satellite
FAC--Fonds d'Aide et de Cooperation de la France
FAO--Food and Agriculture Office of the United Nations
FED Fonds Europeen de Developpement
FONADER--Fonds National de Developpement Rural
GURC--Government of the United Republic of Cameroon
IBRD--International Bank for Reconstruction and Development
IEMVT--Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux
IGN--Institut Geographique National (Centre de Yaounde)
INSEE--Institut National de la Statistique et des Etudes Economiques, Service de la Cooperation
IRAT--Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres
IRCAM--Institut de Recherches du Cameroun, Yaounde
IRCT--Institut de Recherches du Coton et des Textiles Exotiques
LCBC--Lake Chad Basin Commission
OICMA-Organisation International contre le Criquet Migrateur Africain
ONAREST--Office National pour le Recherche Scientifique et Technique
ORSTOM--Office de la Recherche Scientifique et Technique d'Outre-Mer
SCET--Societe Centrale pour l'Equipement du Territoire
SEMRY--Secteur Experimental de Modernisation de la Riziculture de Yagoua
SODEPA--Societe de Developpement de Paturage
SODECOTON--Societe de Developpement du Coton
SOGREAH--Societe Grenobloise l'Etude des Amemaguments Hydrologiques
UNDF--United Nations Development Fund
USAID--United States Agency for International Development
USSCS--United States Soil Conservation Service

Summary of Tables

## List of Figures



## List of Maps

# Resource Inventory of North Cameroon

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*This resource inventory was prepared under PIO/T No. 625-907-2-6750043, Project Activity No. 625-11-995-907, Development Studies of the Sahel-Sudano Zone, for the United States Agency for International Development in accordance with a cooperative agreement with Fonds d'Aide et de Cooperation of France.*

## Summary

This publication is a resource inventory of the administrative region of North Cameroon, excluding the Adamaoua Department. The area is about 10 million hectares in size.

General nature of the area: Relief is relatively low, except for a few mountainous parts. Temperatures are high during the long dry season, and the average annual rainfall ranges from 1,500 millimeters in the south to about 500 millimeters along the Lake Chad shore in the north.

Resource area map for regional planning: Nine resource areas are recognized. Each has a particular and unique pattern of soils, vegetation, topography, and land use. Four areas are characterized by mountains, highlands, or plateaus. Three are in broad, undulating river valleys. Two are on the alluvial plains and delta of the Logone and Chari Rivers.

Human resources: Five major groups of people and 54 tribes are found in the survey area. The population is about 1,400,000. The people are skilled as farmers and cattle raisers. Food production is about equal to consumption.

Livestock resources: Livestock number 2.59 million head and include 36.6 percent cattle, 33.4 percent goats, 27 percent sheep, and 3 percent donkeys, horses, and pigs. These animals are well suited to the harsh environment and the subsistence needs of the traditional producers.

Soil resources: Twenty-nine soil resource units are recognized in the survey area. These natural soil associations are shown on the soil resource unit map at the back of this survey. Soil properties that affect land use are quite variable and are considered in estimating the soil potential. The soils are classed in 5 orders, 11 suborders, and 18 great groups, according to Soil Taxonomy, Agriculture Handbook No. 436, U.S. Department of Agriculture.

Natural plant communities: Sixteen natural plant communities are recognized. These represent the potential natural vegetation that can be maintained using an adequate system of management. Three of these communities consist of natural grassland. The rest are natural savannahs that vary in density of woody vegetation, in productive capacity, and in plant composition.

Water resources: The decrease in rainfall northward in the survey area dictates a reduction in choice of crops. Surface runoff is irregular. It is excessive during the summer rainy season, and flash flooding in lateral basins is common during a 3-month period. Surface water is scarce during the dry season. The Benoue River requires intensive regulation for effective water use; the discharge from the Logone River is marked by large losses due to evaporation. Ground water resources have potential for development in the extreme lower Benoue basin, in the Diamare Plains, and northward. The potential for irrigation development is high, and the choice of water sources depends on the regional water balance affecting the Lake Chad reservoir.

Agronomy: About 45 percent of the survey area has medium to very high potential for crops. Only about 5 percent of the area is cropped. About 23 percent, mainly north of the Benoue River, has medium to high potential for rain-fed rice; and 7 percent has potential for rice if water resources for irrigation can be developed. About 22 percent of the area has medium to high potential for wet-season sorghum, millet, and peanuts.

Livestock management: The livestock industry and livestock management practices are diverse. Livestock marketing manifests a combination of traditional and modern practices. The better grade hides and skins are exported to Europe. Taxation and regulatory laws generally are not favorable to the development of the livestock industry. Nevertheless, six traditional methods of livestock management have been developed. The lands south of the Benoue River offer the greatest potential for development of a livestock industry.

Range: North Cameroon has a high potential for red meat production. About 55 percent of the area is suited only to grazing; any other use would be uneconomical or hazardous to soil and water resources. In general, the rangeland north of the Benoue River is in poor condition; many areas are severely eroded, and conservation programs that include controlled grazing are needed. Control of livestock grazing is the greatest management concern. With good management, the forage production in this area could be increased and soil depletion greatly reduced. The rangeland south of the river has the highest potential for livestock production with the least investment and the greatest immediate economic return.

Social and economic considerations: Cattle raising varies widely among the major groups of people, as do the social attitudes and economic significance attached to it. Customs relating to acquiring and administering land rights are widely diverse. The amount of land available for grazing and for use other than cultivation is greatest in the area south of the Benoue River, but land is scarce where the population density is greater than 20 to 30 inhabitants per square kilometer.

## General Nature of the Area

The survey area is the administrative region of North Cameroon, except for the Adamaoua Department. It is about 10 million hectares in size and extends from about 7 degrees to 13 degrees north latitude.

The survey area is generally referred to as the Northern Plains region. This is a distinct region that is relatively isolated from the rest of the country. It has low relief except for a few mountainous parts, high temperatures during a long dry season, and decreasing rainfall from south to north. Almost one-fourth of the country's population lives in this region.

Elevation ranges from 160 meters, at the point where the Benoue River leaves the area, to more than 2,000 meters, in the mountains of the southern part. Average annual rainfall ranges from about 500 millimeters in the northern part to 1,500 millimeters in the southern part.

## Population, Food, and Agriculture

The region has a population of about 1,400,000. Food production and consumption are about equal. Beef is not a major item in the diet, and 60 percent or more of the beef consumed is imported from Nigeria and Chad. Sheep provide most of the meat; goat meat, fish, and poultry are also part of the diet.

Sorghum, millet, peanuts, rice, manioc, beans, corn, and other vegetables are the major food crops. Except in fields of irrigated rice, almost all tillage is done with a short-handled hoe that has a fan-shaped metal tip. Weeds are a major detriment to crop production. The yields of most food crops are related to the soil resources and individual farming skills. Commercial fertilizers and herbicides are used sparingly. Except for cotton and rice seed, most seed is grown locally. Much of the cotton production (35,000 metric tons) is exported.

## Natural Resources

People, livestock, vegetation, soils, and water are the most important resources of the region. Mineral resources are not considered to be of significant economic importance at present. Ground water is generally sufficient for human and livestock needs but is either insufficient in quantity or too poor in quality for irrigation.

# How This Resource Inventory Was Made

The survey team first assembled and studied existing information on soils, vegetation, geology, climate, water, wildlife, domestic animals, crops, present land use, population, and sociology of the region. Then, using existing soil information, interpretations of satellite imagery, and field observations, members of the team prepared a map showing resource areas and units that have similar potential for range, crops, woodland, wildlife, or a combination of these. The resource areas were outlined on the basis of soil, climate, physiography, vegetation, and other significant characteristics. Meanwhile, other team members made detailed studies of the vegetation, crops, and livestock industry; then they prepared interpretations for each of the resource units. The interpretations include estimates of crop and range yields, following defined management practices; ratings of the potential for various uses; and descriptions of the potential native plant community.

## Climate and Resources

This section discusses the climate in the survey area and the resources, including human, livestock, soil, plant, and water resources.

### Climate

North Cameroon has a tropical climate. Rainfall decreases from south to north, and there is a pronounced dry season persisting long enough that most soils are dry for at least 3 months.

The survey area extends from about 7 degrees to 13 degrees north latitude and includes two of the traditional eco-climatic types in Africa; the Sudanian and the Sahelian types. Subdivisions of these are determined by transitions and combinations of precipitation and temperature modified by the effects of abrupt changes in elevation. In Central and West Africa, climate classifications have been correlated with agricultural and economic development.

Climatic data from several stations in or near the survey area are summarized in table 1, and monthly rainfall and temperatures are shown in table 2.

### Temperature

Average annual air temperatures in North Cameroon are shown in figure 1. These are closely related to latitude and elevation. The average annual temperature varies within the area by as much as 6 degrees. Mountains account for local variations of several degrees. Variations in the monthly average increase northward. The difference between the average summer temperature (June, July, August) and the average winter temperature (December, January, February) is not greater than 5 degrees in any area. The variation in daily temperature may be as much as 20 degrees. The recorded maximum is 45 degrees (Celsius) and the minimum is 12 degrees.

### Precipitation

The atmospheric pressure systems that affect the African continent give rise to air movements which are responsible for the amount and distribution of rainfall. The distribution of rainfall in Central West Africa, from a regional and temporal standpoint, is determined by the position of the inter-tropical front as shown in figure 2. This front is the zone where warm, dry continental air that is brought by northeast trade winds contacts the moist, somewhat cooler maritime air that characterizes southwest "monsoon" circulation.

The range in annual rainfall in North Cameroon is moderately wide, reflecting a sensitive balance in the dominating pressure systems. The inter-tropical front, however, produces a uniform effect in meteorological extremes. The result of this is that diverse areas experience similar variations from the norm, regardless of season, and that local extremes that might occur from isolated storms generally are absent. Figure 3 shows the range in average annual rainfall in North Cameroon.

Data from recording stations in the survey area indicate that monthly rainfall increases from April to August and decreases rapidly from August to October.

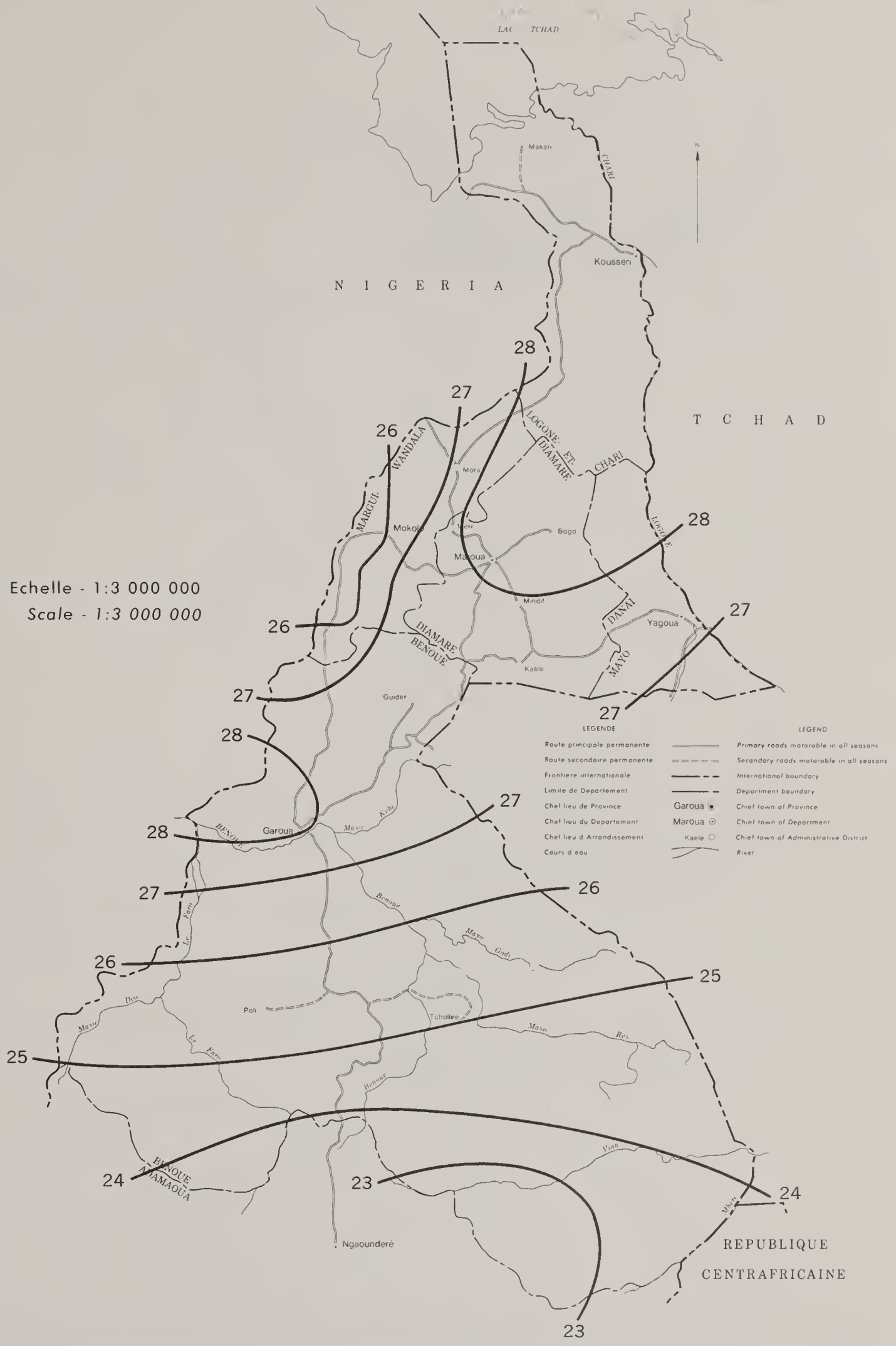
TABLE 1.--Climatic data

[Dashes mean data were not available]

| Stations | Cameroon eco-climate classification within the tropical regime | Average annual rainfall | Average annual temperature | Average annual evaporation | Average annual relative humidity at noon | Dry months | Months with rainfall |
|---|---|---|---|---|---|---|---|
| | | Mm | °C | Mm | Pct | No | No |
| N'Djamena--- | Sahelian---------- | 554 | 28.1 | 3,576 | 30 | 7 | 5 |
| Maroua------ | Sudan-Sahelian------- | 804 | 28.6 | 3,536 | 35 | 6 | 6 |
| Garoua------ | Sudanian---------- | 982 | 28.1 | 2,380 | 39 | 6 | 6 |
| Mokolo------ | Sudanian highlands--- | 961 | 26.0 | ----- | -- | 6 | 6 |
| Poli-------- | Sudanian highlands--- | 1,477 | 25.6 | 1,850 | -- | 5 | 7 |
| Ngaoundere-- | Sudanian highlands--- | 1,574 | 22.2 | 1,822 | 47 | 5 | 7 |

TABLE 2.--Monthly variations in temperature and rainfall

| Stations | Temperature and rainfall | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ngaoundere-- | Average temperature (Celsius)---------- | 21.7 | 22.4 | 25.3 | 23.8 | 22.9 | 21.7 | 21.8 | 21.5 | 21.7 | 22.3 | 21.7 | 21.4 | 22 |
| | Maximum---------- | 30.7 | 30.8 | 33.2 | 29.7 | 28.1 | 27.8 | 26.9 | 26.2 | 27.0 | 28.5 | 29.8 | 30.3 | 29 |
| | Minimum---------- | 12.5 | 14.0 | 17.4 | 17.8 | 17.6 | 16.7 | 16.8 | 17.8 | 16.2 | 16.0 | 13.6 | 12.5 | 15 |
| | Rainfall (mm)-------- | 0 | 0 | 17.2 | 123.6 | 236.6 | 263.2 | 191.1 | 299.5 | 306.7 | 157.3 | 0 | 0 | -- |
| | Number of days--- | 0 | 0 | 5 | 18 | 24 | 24 | 28 | 27 | 20 | 18 | 0 | 0 | -- |
| Garoua------ | Average temperature (Celsius)---------- | 26.5 | 28.5 | 31.7 | 32.4 | 30.0 | 27.4 | 26.3 | 26.8 | 26.2 | 27.3 | 27.6 | 26.0 | 28 |
| | Maximum---------- | 35.5 | 36.3 | 40.2 | 37.7 | 34.0 | 31.4 | 32.4 | 30.0 | 31.0 | 34.4 | 36.5 | 35.2 | 34 |
| | Minimum---------- | 17.7 | 20.0 | 24.3 | 25.2 | 23.8 | 22.1 | 22.6 | 22.0 | 21.8 | 22.2 | 20.0 | 17.7 | 21 |
| | Rainfall (mm)-------- | 0 | 0.5 | 4.9 | 38.0 | 119.9 | 154.7 | 174.0 | 214.0 | 216.0 | 75.0 | 1.4 | 1.2 | -- |
| | Number of days--- | 0 | 0 | 0 | 9 | 11 | 10 | 12 | 17 | 14 | 12 | 0 | 0 | -- |
| Maroua------ | Average temperature (Celsius)---------- | 25.0 | 26.2 | 30.2 | 31.2 | 29.8 | 27.4 | 27.5 | 25.6 | 26.2 | 27.5 | 27.1 | 23.2 | 27 |
| | Maximum---------- | 33.1 | 33.6 | 38.4 | 37.8 | 35.7 | 33.2 | 33.1 | 30.2 | 31.7 | 34.9 | 35.5 | 32.6 | 34 |
| | Minimum---------- | 16.9 | 18.7 | 22.0 | 24.5 | 23.9 | 21.7 | 21.8 | 21.0 | 20.6 | 20.1 | 18.7 | 17.8 | 20 |
| | Rainfall (mm)-------- | 0 | 0 | 0 | 37.7 | 27.0 | 45.2 | 312.7 | 246.8 | 90.8 | 52.1 | 0 | 0 | -- |
| | Number of days--- | 0 | 0 | 0 | 8 | 7 | 11 | 18 | 17 | 13 | 0 | 0 | 0 | -- |
| N'Djamena--- | Average temperature (Celsius)---------- | 23.5 | 25.9 | 30.1 | 32.7 | 32.3 | 30.5 | 27.5 | 26.2 | 27.1 | 28.6 | 27.1 | 24.1 | 28 |
| | Maximum---------- | 33.4 | 35.7 | 39.2 | 41.2 | 40.0 | 37.5 | 33.1 | 30.6 | 32.7 | 36.4 | 36.5 | 33.9 | 35 |
| | Minimum---------- | 13.9 | 16.5 | 19.9 | 23.7 | 25.0 | 24.0 | 22.7 | 22.1 | 22.3 | 21.8 | 17.9 | 14.8 | 20 |
| | Rainfall (mm)-------- | 0 | 0 | 0 | 4.3 | 31.3 | 52.9 | 136.9 | 231.0 | 75.6 | 21.1 | 1.3 | 0 | -- |




Echelle - 1:3 000 000
*Scale - 1:3 000 000*

Figure 1 - Température de l'air, isothermes annuelles moyennes (Celsius)

*Average annual air temperature (Celsius)*

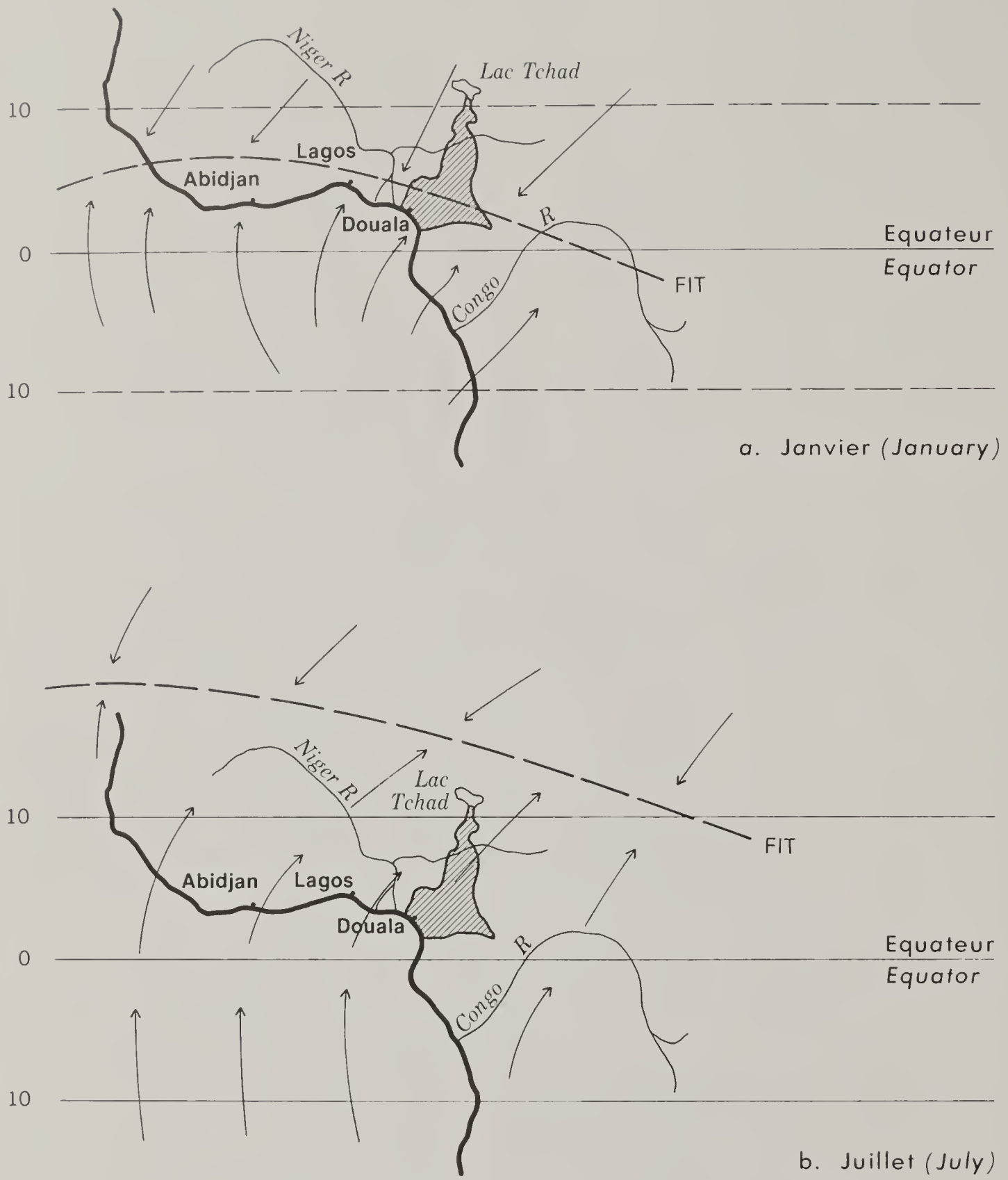



Figure 2 - Variations de la position du front intertropical (FIT) au voisinage du Cameroun

*Variations in the position of the intertropical front (FIT) in Cameroon*

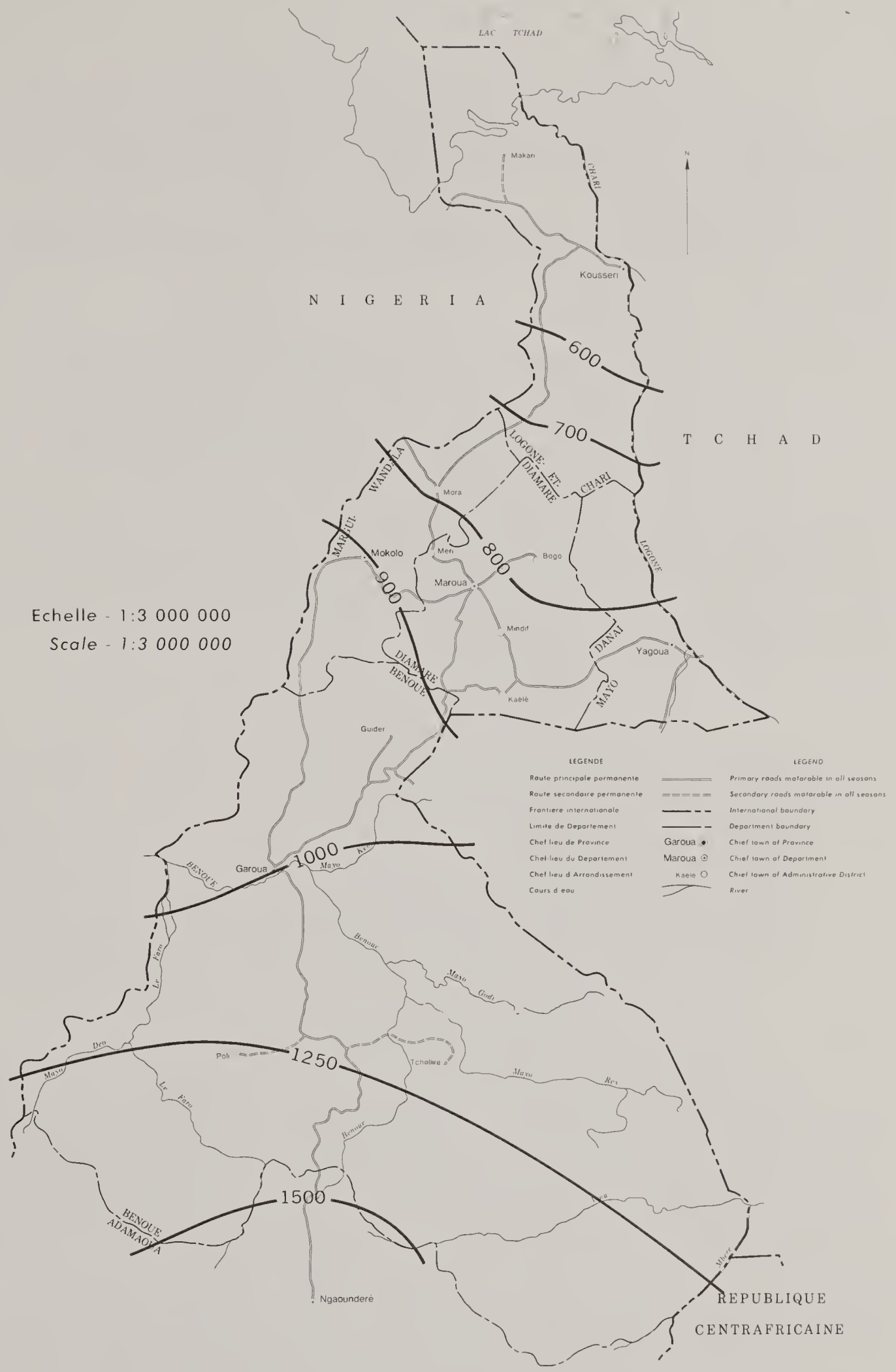



Figure 3 - Precipitations moyennes annuelles (en mm)

*Average annual rainfall (in millimeters)*

General assumptions about rainfall intensity can be made from a study by Brunet and Moret, entitled "Complement a l'etude generale des averses exceptionelles en Afrique Occidentale," which was designed for the African tropical environment.

For a storm with 105 millimeters of rainfall and a frequency expectation of once in 10 years, the following intensities are probable:

| Duration | Intensity |
|---|---|
| 5 minutes | 140 millimeters per hour |
| 20 minutes | 103 millimeters per hour |
| 30 minutes | 86 millimeters per hour |
| 45 minutes | 75 millimeters per hour |
| 60 minutes | 67 millimeters per hour |

These data indicate that 86 percent of that storm's volume occurs at intensities equal to or exceeding 81 millimeters per hour.

The Maroua Agriculture Station has been recording rainfall data for the longest period and the statistical pattern of its data is considered typical for rainfall in the survey area.

Maroua

| | |
|---|---|
| Period of record | 1931-1970 |
| Maximum annual rainfall | 1,119 mm |
| Minimum annual rainfall | 548 mm |
| Average annual rainfall | 804 mm |
| Median annual rainfall | 779 mm |
| Coefficient of variation | 0.176 |
| Coefficient of irregularity | 1.64 |
| Predicted annual rainfall: 9 years in 10 | more than 610 mm but less than 1,000 mm |

## Soil and water relationships

The moisture available to most plants is related to the capacity of the soil to absorb and retain water. This is an important property of soils, particularly in areas where rainfall is not plentiful. The capacity of mineral soils to retain rainfall in a meter of depth can range from 5 centimeters in sandy soils to 15 centimeters or more in some finer textured soils.

Figure 4 illustrates the water balance for a well-drained soil in the vicinity of Maroua. In this figure average monthly values for rainfall (R), potential evapotranspiration (PE), and actual evapotranspiration (AE) are plotted. Potential and actual evapotranspiration are calculated following a procedure outlined by Thornthwaite. The potential evapotranspiration is the amount of moisture that could be lost from a moist soil where disease-free plants are growing without soil or nutrient limitations. The actual

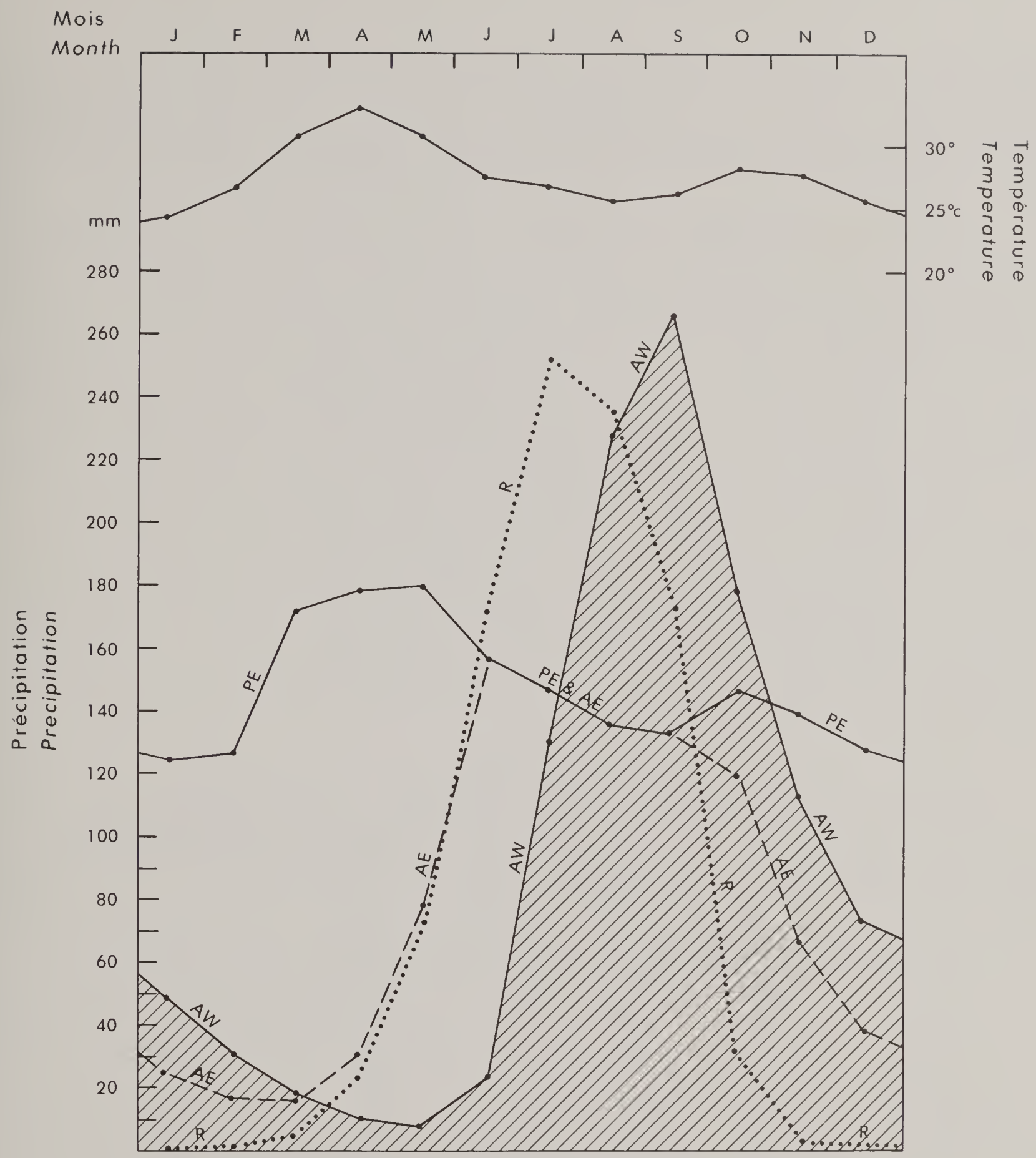



Figure 4 - Equilibre climatologique et équilibre sol/eau à Maroua (altitude: 421 m).
Période d'observation: 1955 - 1960

*Climatic balance and soil water balance at Maroua (elevation: 421 meters).*
*Period of record: 1955 - 1960*

evapotranspiration is the amount of moisture lost from the soil during plant growth at Maroua. The annual values for potential evapotranspiration, actual evapotranspiration, and rainfall are 1,774,969, and 968 millimeters, respectively. It is assumed that the soil will retain at least 300 millimeters of moisture within the root zone. Monthly air temperatures are plotted in the upper part of figure 4.
excess of the actual evapotranspiration remains in the soil. The moisture in the soil at the end of each month is calculated by adding the amount of available moisture at the end of the previous month and the amount of rainfall during the month, and then subtracting from this the actual evapotranspiration that occurred during the month. For example, at the end of June about 25 millimeters of moisture available to plants was stored in the soil. During July, rainfall was about 250 millimeters and plants utilized about 140 millimeters of moisture. At the end of July, approximately 135 millimeters of moisture was stored in the soil (25 + 250 - 140 =135). This, then, is the amount of available moisture for use by plants in August.

The shaded part of figure 4 shows the amount of moisture in the soil that is available for plants. For about 110 days from July through October the available water in the soil exceeds the potential evapotranspiration, and plant growth is rapid. In the unshaded part below the potential evapotranspiration graph, figure 4 shows that growth is restricted by lack of moisture until the next period of high rainfall. For soils that retain less than the maximum available water for plants (about 260 millimeters at Maroua) this period is shorter because excess water moves through the soil to replenish the ground water.

## Relative humidity

The average annual relative humidity at noon at selected stations is presented in table 1. Average variations in relative humidity during the day at the Maroua station from 1956 to 1968 are as follows:

Time of day and relative humidity

| | 2400 | 0600 | 1200 | 1800 |
|---|---|---|---|---|
| January----- | 33 | 34 | 15 | 23 |
| February---- | 25 | 27 | 12 | 15 |
| March------- | 23 | 23 | 12 | 16 |
| April------- | 43 | 47 | 18 | 26 |
| May--------- | 62 | 67 | 33 | 45 |
| June-------- | 82 | 91 | 51 | 62 |
| July-------- | 89 | 90 | 60 | 76 |
| August------ | 85 | 94 | 68 | 85 |
| September--- | 95 | 95 | 62 | 84 |
| October----- | 85 | 82 | 38 | 63 |
| November---- | 51 | 50 | 22 | 36 |
| December---- | 39 | 40 | 18 | 28 |

## Insolation

The average number of hours of sunshine for each month, recorded at two stations, is as follows:

| | Station | |
|---|---|---|
| | Maroua | Garoua |
| January | 286 | 286 |
| February | 277 | 252 |
| March | 264 | 288 |
| April | 252 | 270 |
| May | 241 | 275 |
| June | 208 | 248 |
| July | 180 | 188 |
| August | 162 | 193 |
| September | 191 | 201 |
| October | 254 | 277 |
| November | 284 | 302 |
| December | 298 | 316 |
| Year | 2,895 | 3,097 |

## Evaporation

Average monthly evaporation from a water surface has been determined by the Piche method. Averages, in millimeters, recorded at selected stations are as follows:

| | Station | | | | |
|---|---|---|---|---|---|
| | Ngaoundere | Poli | Garoua | Maroua | N'Djamena |
| January | 284 | 236 | 276 | 228 | 345 |
| February | 263 | 279 | 275 | 296 | 389 |
| March | 241 | 323 | 350 | 365 | 506 |
| April | 133 | 225 | 324 | 304 | 451 |
| May | 84 | 127 | 201 | 203 | 362 |
| June | 64 | 66 | 123 | 191 | 265 |
| July | 61 | 55 | 99 | 81 | 149 |
| August | 61 | 56 | 76 | 60 | 74 |
| September | 56 | 51 | 75 | 83 | 96 |
| October | 97 | 81 | 115 | 143 | 206 |
| November | 197 | 149 | 229 | 229 | 335 |
| December | 281 | 202 | 238 | 213 | 341 |
| Year | 1,822 | 1,850 | 2,380 | 2,396 | 3,519 |

## Resource Areas for Regional Planning

The nine resource areas shown on the resource area map at the back of this survey are described in this section. These descriptions together with the map can be useful in determining the potential of a resource area, in planning land use, and in developing resources on a regional basis.

A resource area consists of geographically associated soil resource units that are as uniform as possible in land use, elevation and topography, human and livestrock resources, climate, plant communities, water, and soil. Soil resource units generally are several thousand hectares in size. They are described in another part of this publication.

Table 3 shows the size of each resource area and the extent and distribution, in hectares, of specified land uses.

## Description and potential of resource areas

### Resource area A--Logone-Chari Delta

This resource area is in the northern part of the Logone-Chari department and takes in the main migration route of herders between Nigeria and Chad. It covers 500,000 hectares and extends from Lake Chad to a short distance south of the migration route. The Lake Chad shoreline can vary laterally as much as 20 kilometers, depending on annual rainfall and season of the year.

Human resources: This area is fairly well settled, averaging about 12.5 persons per square kilometer. The population, however, is mostly concentrated in Makari and Kousseri.

The people are Islamic, and Foulbe and Arab-Choa make up 70 percent of the population. They are essentially cattle raisers, moving from pasture to pasture with their herds, and farm only on a small scale. The other tribes, mainly Kotoko, are farmers and fishermen.

Livestock: Livestock in the area is owned mostly by settled Arab-Choa farmers. The herds and flocks graze fallow cropland during the rainy season and migrate short distances to Lake Chad or the Yaere Plains in the dry season. Migratory cattle belonging to the Mbororo-Foulbe are grazed in this area during the dry season.

Land use: Most of this resource area is rangeland. The range is mostly in fair to very poor condition. Less than 4 percent of the area is cropland. Dry-season sorghum and corn are grown on the clayey soils in the lowlands. Wet-season sorghum and vegetables are grown on the sandy soils on the slightly elevated ridges.

Elevation and topography: The elevation ranges from 280 to 300 meters. The Logone-Chari Delta is an area of low reflief. It consists of the gentle slopes of the Lake Chad shore and the channeled delta of the Logone and Chari Rivers. Landforms consist mainly of shoreline or alluvial deposits.

Climate: The annual precipitation is 500 to 600 millimeters. Most of the precipitation falls from June to September, and 85 percent of the precipitation falls during July and August. The average annual temperature is 28° C.

TABLE 3.--Extent and land use by resource area

| Resource area | Map symbol | Size | Land use | | | |
|---|---|---|---|---|---|---|
| | | | Range | Crops | Wildlife forest reserve | Miscellaneous |
| | | Hectares | Hectares | Hectares | Hectares | Hectares |
| Logone-Chari Delta | A | 500,000 | 393,900 | 15,700 | 2,700 | 87,700 |
| Yaere Alluvial Plains | B | 800,000 | 531,500 | 41,200 | 193,000 | 34,300 |
| Diamare Plains | C | 1,800,000 | 1,306,300 | 277,100 | 191,600 | 25,000 |
| Mandara Highlands | D | 600,000 | 370,300 | 107,800 | 61,000 | 60,900 |
| Lower Benoue Valley | E | 1,230,000 | 1,115,000 | 44,800 | 0 | 70,200 |
| Intermediate Benoue Valley | F | 2,000,000 | 1,134,000 | 79,000 | 726,000 | 60,000 |
| Upper Benoue-Logone Valleys | G | 1,300,000 | 1,233,400 | 11,100 | 0 | 55,500 |
| Mountains of South Benoue | H | 600,000 | 531,600 | 8,400 | 0 | 60,000 |
| High Plateaus | I | 1,050,000 | 953,900 | 6,100 | 0 | 90,000 |

Potential plant community: The alluvial flood plain is a natural savannah on which the potential plant community is characterized by Andropogon gayanus, Hyperrhenia rufa, Setaria pallidifusca, Setaria communis, and scattered acacia and other trees. The present plant community is primarily annual grasses, acacia trees, and shrubs that have increased in density.

The strongly alkaline, eroded clays on the plains support a natural savannah on which the potential plant community is characterized by Hyperrhenia rufa, Eragrostis robusta, annual Setaria and Pennisetums, scattered acacia and other trees, and shrubs. The present plant community is primarily annual grasses and acacia trees.

Water: Surface water is abundant during the wet season and scarce during the long dry season, except along the Chari River and Lake Chad. Artesian ground water is available. It is suitable for humans and livestock but not suitable for irrigation because of its high content of sodium bicarbonate. Also, the high cost of developing such an irrigation system is prohibitive.

Soils: Flooded sodic soils (Natraqualfs) and dark clayey soils (Pellusterts) are the most extensive in this area. Less extensive but more important are the flooded lakeshore soils (Tropaquepts).

Potential: This area has low potential for range and cropland. A small area along the Lake Chad shore has fair potential for cropland.

Resource area B--Yaere Alluvial Plains

This resource area is in the southern part of the Logone-Chari department and the eastern part of the Mayo Danai department. It covers 800,000 hectares and includes the flood plain of the Logone River between Kousseri and the Chad border south of Yagoua. An unusual feature of this area is the Yaere, a vast area of 240,000 hectares used for dry-season grazing. From July to October the Yaere is flooded to a depth of 80 to 120 centimeters, except for high spots. During this period, the grass grows to a height of 3 meters. It is grazed after the water recedes. Most of the area is burned annually.

Human resources: The Waza and Grand Yaere sections have few inhabitants. The population is mostly concentrated in the Yagoua and the Kar-Hay areas where the density is 35 persons per square kilometer.

The principal tribes in this resource area are the Mousegoum along the Logone River and the Massa in the Yagoua area. These lowland people are excellent farmers and also raise cattle.

Livestock: There are very few cattle in the resource area year round, but it is estimated that as many as 200,000 migratory cattle pass through the Yaere in the dry season.

Land use: Most of this resource area is rangeland. The range is mostly in fair condition, and some areas are in good condition. Nearly one-fourth of the area is in the Waza National Park, a wildlife preserve. Less than one-twelth of the resource area is cropland. Rice and dry-season

sorghum are grown on the clayey soils of the lowlands of the Logone and Danai-Fianga Rivers. Wet-season sorghum, millet, cotton, and peanuts are grown on the loamy soils of the river levees.

Elevation and topography: The elevation ranges from 300 to 320 meters. The Logone-Chari and Mayo-Danai departments are areas of low relief. They include nearly level lowlands, floodways of the Logone River, and wet depressions of the Danai-Fianga River system. Local relief is less than 2 meters, and landforms are mainly alluvial deposits.

Climate: The annual precipitation is 600 to 800 millimeters. Most of the precipitation falls from mid-April to early October. In the Logone-Birni and Waza areas, 80 percent of the precipitation falls in July, August, and September. At Yagoua, almost 90 percent falls from June to September. The average annual temperature is 27.5° C.

Potential plant community: Three major potential plant communities are in this resource area. An open savannah on the sandy ridges adjacent to the Logone River is characterized by Andropogon gayanus, Pennisetum species, Ctenium species, and acacia and other trees. This plant community has been greatly altered by excessive grazing and now consists mainly of annual grasses and acacia trees.

In the grassland on the Yaere flood plain, the potential plant community is characterized by Oryza barthii, Hyperrhenia rufa, Echinochloa species, and Sporobolus pyramidalis. The present plant community consists of high-producing annual sorghums and some of the perennial grasses of the potential plant community.

The third potential plant community is on a natural savannah, primarily on broad alluvial flood plains. It is characterized by Andropogon gayanus, Hyperrhenia rufa, Setaria pallidifusca, Setaria communis, and scattered acacia trees. The original plant community has been altered by excessive grazing and now consists mainly of annual Aristida species, Setaria species, and Hyperrhenia rufa, a fire-resistant perennial.

Water: The Logone River and the rivers and streams of the Diamare Plains provide an abundance of water during the wet season. Surface water is scarce during the dry season, except along the Logone River. Artesian ground water is available. It is suitable for humans and livestock but is not suitable for irrigation because of its high content of sodium bicarbonate. Also, the cost of developing an irrigation system is too high.

Soils: Dark gray clayey soils (Pellusterts) and stratified soils (Fluvaquents) on flood plains and alluvial plains are the most extensive in this area. Also extensive are the flooded, gray clayey soils (Tropaqualfs) in broad wet depressions. Minor soils are elevated, sandy river-levee deposits (Fluvaquents).

Potential: This area has high potential for range, rice, dry-season sorghum, and forage crops.

Resource area C--Diamare Plains

This resource area is between the Mandara Mountains and the flood plain of the Logone River. It includes the Diamare, Margui-Wandala, and Mayo Danai departments. It covers 1,800,000 hectares and is the largest crop-producing area in the North Cameroon survey area. Most of the "sols hardes," soils that are high in sodium and very unproductive, are in this area. Erosion is severe in some parts of the area.

Human resources: This area is heavily populated, averaging about 40 persons per square kilometer. The three dominant tribes in this area are the Islamic Foulbe in the northern part of the area and the pagan Toupouri and Guiziga in the southern part. The Foulbe and Toupouri are traditionally cattle raisers, but they are also good farmers. The Toupouri specialize in the cultivation of transplanted dry-season sorghum. The Guiziga are farmers.

Livestock: This area is an extensive plain that supports a dense livestock population. The livestock are owned primarily by the Foulbe in the western part of the area and by the Kotoko, Mousegoum, and Massa in the eastern part. Farmers other than the Foulbe own many oxen for cultivation. In the dry season most of the livestock is taken to the Yaere or to other seasonally flooded areas along the Logone River.

Land use: Most of this resource area is rangeland and is in poor condition. About one-sixth of the area is cropland. Wet-season sorghum, millet, cotton, and peanuts are grown on the better drained soils. Dry-season sorghum and some rice are grown on the wet soils.

Elevation and topography: The elevation ranges from 320 to 600 meters. The area is mostly plains, lowlands, and foot slopes adjacent to granitic hills and mountains. Landforms are mainly erosional surfaces of low relief, but dunes and interdune depressions occur in parts of the area.

Climate: The annual precipitation is 700 to 900 millimeters. Most of the precipitation falls from April through October, and 75 percent of the precipitation falls during July, August, and September. The average annual temperature is 28° C.

Potential plant community: The stony loamy slopes of hills and mountains rising out of the plains form a natural savannah on which the potential plant community is characterized by Hyperrhenia rufa, Andropogon gayanus, Pennisetum species, Acacia senegal, and Balanites aegyptica. The plant community has been altered greatly by heavy livestock grazing and annual burning. The understory is mainly annual grass.

On the alluvial flood plain, the potential plant community of the natural savannah is characterized by Andropogon gayanus, Hyperrhenia rufa, Setaria pallidifusca, Setaria communis, and scattered acacia and other trees. The present plant community is primarily annual grasses. Trees and shrubs have increased in density.

On the deep sands and sandy loams on windformed terraces and sloping uplands, the potential plant community is Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia species, Ficus species, Commiphora africana, and Seleracarya bicoene. The present plant community is mainly annual grasses and acacia trees.

Soils: Sodic soils (Natraqualfs), locally called "sols hardes," dark gray clayey soils (Pellusterts), and light brown clayey soils (Chromusterts) are the most extensive. Also in this area are deep sandy soils (Ustropepts), flooded stratified soils (Fluvaquents), and wet soils (Tropaquents) in depressions.

Potential: This area has high potential for crops and low to medium potential for livestock.

Resource area D--Mandara Highlands

This resource area is in the west-central part of the region. It covers 600,000 hectares in the Margui-Wandala department. A unique aspect of this area is the specialized farming of terraced mountain slopes. Erosion is a serious problem on the steep slopes. The southern part of the area near Rumsiki is a plateau with numerous scenic volcanic extrusions.

Human resources: This is the most densely populated area in North Cameroon, averaging 50 persons per square kilometer. In certain sections in the Mokolo-Mora area, population exceeds 250 persons per square kilometer. Most of the people belong to the Mafa and Mora tribes of the mountain people and to the Kapsiki tribe of the highland people. All the mountain people are farmers, and all have cattle. The Kapsiki too are primarily farmers.

Livestock: The cattle are owned mainly by the Mafa, Mofoa, and Mora tribes in the mountain area and by the Kapsiki tribe on the plateau. Most cattle are kept in pens and are sacrificed on special occasions. The Kapsiki, who traditionally raise livestock, are limited mainly to a few trypano-tolerant cattle, sheep, and goats.

Land use: Most of the northern part of this resource area consists of mountain slopes that are cultivated, and most of the southern part is rangeland. The upland plateau in the Rumsiki-Bourrak area is used primarily for grazing domestic and nomadic herds. Most of the farming is on terraces on steep mountain slopes in the areas of the Makola, Meri, and Mora tribes. In the Rumsiki area and to the south, the hillcrests and ridges are farmed. The rangelands are grazed by local livestock and transient herds.

Elevation and topography: The elevation ranges from 600 to 1,200 meters. The Margui-Wandala department is mountainous; slopes range from 30 to 70 percent. Large granitic boulders and rocks are on the surface. The plateaus are bisected by intermittent streams. Near Rumsiki is a high plateau that has numerous volcanic extrusions.

Climate: The annual precipitation is 800 to 1,000 millimeters. Most of the precipitation falls during the season starting in April and ending in October, and 85 percent of the precipitation falls in July, August, and September.

Average annual temperature is 27° or 28° C. The hottest period of the year extends from March to May. The June rains have a cooling effect over the area, and the temperature remains moderate until November when it starts warming. Temperatures are lower on the mountaintops than in the valleys.

Potential plant community: On the steep, rocky slopes, the potential plant community of the natural savannah is characterized by Hyperrhenia rufa, Heteropogon contortus, Andropogon gayanus, Aristida, and scattered Ficus, Balanitis aegyptica, and Acacias. Cultivation and continuous excessive grazing have destroyed most of the climax vegetation. The present plant community is mostly annual grasses. Very few of the climax species remain.

On the upland plateau, the potential plant community is grassland characterized by Hyperrhenia rufa, Pennisetum pedicellatum, and Andropogon gayanus. It has been altered by grazing but still remains in fair to good condition.

On the colluvial foot slopes and outwash plains, the potential plant community of the natural savannah is characterized by Hyperrhenia rufa, Pennisetum species, Ctenium species, and tree species of the genera Ficus, Balanitis, and Acacia. The present plant community consists of many annual grasses and a few perennial grasses.

Water: Water for human and livestock consumption is from wells, seeps, and springs. Many of the seeps and springs are dry during the dry season. There are no known aquifers that can be developed for irrigation. All farming depends on rainfall and surface water, but many areas have potential for developing ponds for livestock.

Soils: Steep, shallow, stony soils (Ustorthents) on mountain slopes and plateaus are the most extensive in this area. They are commonly terraced in areas of dense population. Also extensive are very deep sandy soils (Ustifluvents and Ustipsamments) on mountain foot slopes and outwash plains. Rockland is of minor extent.

Potential: This area has low potential for crops and low to medium potential for use as rangeland. Shallowness to bedrock and steep slopes are the main limitations. Social constraints are likely to limit development.

## Resource area E--Lower Benoue Valley

This resource area is on each side of the lower reaches of the Benoue River from the Nigerian border to the Tchollire Mountains and in the vicinity of Rey Bouba. It is 1,230,000 hectares in size. The zone north of the Benoue River has been cleared of the tsetse fly, but the part south of the river remains infested.

Human resources: The area is thinly populated, averaging about six persons per square kilometer. The largest population concentration is in the Garoua area. The Foulbe are the dominant tribe, and they traditionally are cattle raisers. The Bata tribe are fishermen who live in small communities along the banks of the Benoue and Faro Rivers.

Livestock: Most of the livestock is owned by the Foulbe. Cattle are most numerous, but sheep and goats are also important. Some Mbororo cattle cross the area from wet-season grazing in Nigeria to dry-season grazing in the Central African Republic.

Land use: This resource area is almost entirely rangeland. The range is in good condition south of the Benoue River, but tsetse flies are a problem there. Range is in fair condition north of the river. Cropland, which makes up less than 1 percent of the area, is mainly along the Garoua-Ngaoundere route and on the river lowlands. Wet-season sorghum, cotton, and peanuts are the main crops on the sandy uplands. Rice and dry-season sorghum are grown on the lowlands along the river.

Elevation and topography: Elevation ranges from 160 to 300 meters. The area is mainly lowlands and long gentle slopes extending to the surrounding more rolling uplands and rocky hills.

Climate: The annual precipitation is 900 to 1,250 millimeters. The wet season starts early in April and ends late in October. More than 85 percent of the total annual precipitation falls during June, July, August, and September. The average annual temperature is 27° C.

Potential plant community: On the gently rolling, deep loamy and sandy soils the potential plant community of the savannah is characterized by Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, and species of Ficus, Acacia, Commiphora, and Seleracarya. The present plant community has not greatly changed from the potential community.

On the annually flooded alluvial flood plain of the river, the potential plant community is primarily the perennial grasses Andropogon, Panicum, Echinochloa, and Hyperrhenia. Mimosa shrubs occasionally grow in the wetter areas. The present plant community has not greatly changed from the potential community, but some annual sorghums have increased.

On lowland soils that are wet because of seeps and springs, the potential plant community is Andropogon gayanus, Echinochloa pyramidallis, Sporobolus pyramidallis, Hyperrhenia rufa, Panicum species, and Cypress species. The present plant community is similar to the potential community.

Water: The Benoue River and its tributaries provide abundant water during the wet season. More than one-fourth of the area is flooded for brief to long periods. Surface water is scarce during the dry season, except along the Benoue River and its main tributaries. Ground water is available in moderate amounts from sandstone formations at elevations of less than 250 meters.

Soils: Wet soils (Tropaquents) in depressions, dark gray clayey soils (Pellusterts) on the alluvial plain, and gently sloping deep sandy soils (Paleustalfs) on uplands are extensive. Shallow stony soils (Ustropepts), sodic soils (Natraqualfs), deep and shallow sandy and loamy soils (Haplustalfs), and Rockland are of minor extent.

Potential: This area has high potential for crops, especially irrigated crops, and high to very high potential for livestock use.

Resource area F--Intermediate Benoue Valley

This resource area is the largest in the North Cameroon inventory region. It is in the Benoue department and covers 2 million hectares. The population is sparse in the southern part where the tsetse fly has not been controlled. Herders migrate through the area on their journeys between Nigeria, Chad, and the Central African Republic during the dry season.

Human resources: The largest concentration of people is in the Guider area where there are 33 inhabitants per square kilometer. In the rest of the area the population density is 7 inhabitants per square kilometer. The Bana, Daba, Guider, and Goude tribes inhabit the northern part of the area. These people are farmers. The Goude also raise cattle. The Eali and Foulbe tribes also inhabit the northern part of the area. They farm and raise cattle.

Livestock: Most of the livestock is owned by the Foulbe. Cattle are the primary livestock, but sheep and goats are kept in the villages. There are a few humpless trypano-tolerant cattle, and nomadic herds enter the area in the dry season. Tsetse flies are a serious problem south of the Benoue River.

Land use: Most of this resource area is rangeland. More than one-third of the range is in wildlife reserves--Reserve de Foune du Faro, Parc National de la Benoue, and Parc National de Boubandjidah. The range is generally in good condition in the southern part of the area and fair in the northern part. Less than 5 percent of the area is cropland. Sorghum, peanuts, and cotton are the main crops.

Elevation and topography: The elevation ranges from 300 to 600 meters. This area consists of low hills, valleys, gently sloping and gently rolling uplands, and lowlands. Almost all of the landforms are erosional surfaces.

Climate: The annual precipitation is 950 to 1,250 millimeters. The wet season extends from early in April to late in October. More than 80 percent of the precipitation falls in June, July, August, and September. The average annual temperature is 26.5° C.

Potential plant community: On the alluvial flood plain, the potential plant community of the open savannah is characterized by Andropogon gayanus, Hyperrhenia rufa, Setaria pallidifusca, Setaria communis, and scattered acacia trees. The present understory is primarily annuals. Trees and shrubs have increased in density.

On the nearly level, clayey soils of the lowlands, the potential plant community of the natural savannah is characterized by Hyperrhenia rufa, Andropogon gayanus, Anogeissus leicarpus, Terminalia siberiana, and Butyrospermum parkii. The present plant community is the same as the potential community, but plant production is 25 percent lower.

On the stony, loamy slopes of hills and mountains that rise out of the plains, the potential plant community is characterized by Hyperrhenia rufa, Andropogon gayanus, Pennisetum species, and scattered Acacia senegal and Balanites aegyptica trees. Frequent burning has reduced plant vigor in some places, and production has been reduced by 20 to 25 percent.

On the deep, loamy soils in areas of gently rolling topography, the potential plant community of the savannah is characterized by Hyperrhenia rufa, Pennisetum pedicellatum, and Andropogan gayanus and tree species of the genera Ficus, Acacia, Commiphora, and Seleracarya. The present plant community is not greatly different from the potential community.

The gently sloping, red sandy loam soils that have an iron-cemented pan support a plant community of Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia and Ficus species, Commiphora africana, and Seleracarya bierre. The present plant community is similar to the potential community, but plant production is 25 percent lower.

The potential plant community on the deep sand to sandy loam soils on wind-formed terraces and sloping uplands is characterized by Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia and Ficus species, Commiphora africana and Seleracarya bierre. The present plant community is similar to the potential community, but plant production is 25 percent lower.

Water: Water is abundant during the wet season. Underground water sources are not dependable during the dry season. Adequate aquifers are limited.

Soils: Gray, clayey soils (Tropaqualfs) on lowlands and shallow, gravelly soils (Ustropepts, shallow) on hills are the most extensive. Steep, stony soils (Ustorthents) and vertic, clayey soils (Chromusterts and Pellusterts) are also extensive. Deep, shallow ferruginous soils (Haplustalfs), wet soils (Tropaquepts) on lowlands, and very deep, sandy soils (Plinthustalfs) on uplands are of minor extent.

Potential: This area has medium potential for crops and medium to high potential for livestock development.

## Resource area G--Upper Benoue-Logone Valleys

This resource area is in the southeastern part of the Benoue department in the upper reaches of the Logone River and Vina River watersheds. It covers 1,300,000 hectares. Tchollire, Sorombe, and Tuboro are important communities. Herders from Chad and the Central African Republic use the area during seasonal migrations.

Human resources: This area is very thinly populated, averaging fewer than two persons per square kilometer. The Dourou, Lakka, Lame, and Pape tribes predominate. None are cattle raisers. The people in the eastern part of the area use oxen in cultivating cotton.

Livestock: Cattle are of very minor importance in this area, but sheep and goats are kept in the villages. Nomadic herds graze the area during seasonal migration between Nigeria and the Central African Republic. Tsetse flies are a serious problem.

Land use: Almost all of this resource area is rangeland. The range is in good condition. Less than 1 percent of the area is cropland. Wet-season sorghum, cotton, millet, peanuts, and corn are the main crops.

Elevation and topography: The elevation ranges from 600 to 900 meters. Most of the area is on broad uplands of low relief and consists of a series of of crests between rivers and some shallow swales. Low hills and associated broad valleys are also extensive.

Climate: The annual precipitation is 1,150 to 1,250 millimeters. The wet season starts early in April and extends to late in October. More than 80 percent of the precipitation falls in June, July, August, and September. The average annual temperature is 26° C.

Potential plant community: On the gently sloping red sandy loam soils that have an iron-cemented pan, the plant community is Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia and Ficus species, Commiphora africana, and Seleracarya bierre. The present plant community is similar to the potential community, but plant production is 25 percent lower.

On the deep sandy soils of the gently rolling savannah, the potential plant community is characterized by Hyperrhenia rufa, Pennisetum pedicellatum, and Andropogon gayanus and the species Ficus, Acacia, Commiphora, and Seleracarya. The present plant community has not been greatly altered.

Water: Surface water is adequate only in the wet season. Ground water is adequate for human and livestock requirements. No water suitable for irrigation is available.

Soils: Very deep sandy soils (Plinthustalfs) on uplands are the most extensive. Deep ferruginous soils (Haplustalfs) and long-saturated soils (Tropaquepts) on foot slopes are also extensive.

Potential: This area has high potential for crops and medium to high potential for livestock use.

## Resource area H--Mountains of South Benoue

This resource area consists of eight small mountain complexes in the Benoue department. It is 600,000 hectares in size. The largest mountains are in the Poli, Tchollire, and Sorambeo areas. Poli is a scenic area. The roads from Poli to Voko and from Poli to Bantadja are picturesque routes.

Human resources: This mountain area is sparsely populated, averaging about six persons per square kilometer. The Doaya are the largest tribe. These people traditionally are cattle raisers.

Livestock: Small numbers of the Poli breed of cattle and migratory herds graze the area. The people of the Poli Mountains developed the Poli breed of cattle, which are trypano-tolerant. The Doaya raise semiwild cattle. Sheep and goats are also in the area.

Land use: The resource area is almost entirely rangeland. The range condition is good. Less than 2 percent of the area is cultivated. Sorghum, millet, and peanuts are the main crops.

Elevation and topography: Elevation generally ranges from 400 to 1,200 meters, but several mountain peaks range from 1,500 to 2,000 meters. More than 80 percent of the area is steep mountains. The rest consists of foot slopes and alluvial fans around the perimeter of the Poli Mountians.

Climate: The annual precipitation is 1,200 to 1,500 millimeters. The wet season starts early in April and extends to late in October. More than 85 percent of the precipitation falls in June, July, August, and September. The average annual temperature is 25.5° C.

Potential plant community: On the steep mountain slopes the potential plant community of the savannah is characterized by Imperata, Pennisetum, Panicum, and Erogrostis species and several species of trees, two of which are Anona arenara and Crossopteryx. Use and management have not altered this plant community.

Water: Water is scarce. Runoff is rapid, and streamflow is generally light or intermittent. Ground water is not available because there are no deep wells, and shallow wells are not dependable during the dry season.

Soils: Steep, shallow stony soils (Ustorthents) are the most extensive. Rockland and moderately deep stony soils (Dystropepts) are also extensive.

Potential: This area has very low potential for crops because of steep slopes and shallow stony soils, and it has medium potential for rangeland.

## Resource area I--High Plateaus

This resource area is in the southern part of the Benoue department. It covers 1,050,000 hectares and includes the northern limits of the Adamaoua Plateau. It is an isolated area with no major routes or communities. Population is sparse and widely scattered. The plateau summits and crests are heavily grazed.

Human resources: This is possibly the least populated area in North Cameroon, averaging fewer than two persons per square kilometer. The Mboum tribe predominates. The people are farmers, and only a few raise cattle.

Livestock: Because this area is mostly uninhabited, the number of livestock is also very low. There are very few cattle, but sheep and goats are owned by almost all the families.

Land use: This resource area is almost entirely rangeland. The range is in fair to good condition. Less than 1 percent is cropland. Wet-season sorghum, cotton, peanuts, and corn are grown.

Elevation and topography: The elevation ranges from 900 to 1,600 meters. This area consists of broad plateau summits bordered by convex ridges and long slopes that grade to steep escarpments.

Climate: The annual precipitation is 1,250 to 1,500 millimeters. The wet season starts late in February or early in March and extends to late in October. Precipitation of more than 100 millimeters per month falls in the period April through September. The average annual temperature is 25° C.

Potential plant community: On the steep mountain slopes, the potential plant community of the savannah is characterized by Imperata species, Pennisetum species, Panicum species, Erograstis species, and several species of trees. Past use and management have not altered the plant community.

On the plateau, the potential plant community of the natural savannah is characterized by Andropogon gayanus, Panicum species, Pennisetum species, Imperata species, Schizachyrium species and three kinds of trees--Bridelia, Cussonia bartine, and Ficus thonnigu. The present plant community is the same as the potential community, but production is 25 to 35 percent lower.

Water: Surface water is adequate in the 9 months of the wet season, and ground water is readily available for human and livestock needs all year.

Soils: Moderately deep stony soils (Dystropepts) and steep shallow gravelly soils (Ustorthents) are the most extensive. Very deep fertile soils (Tropohumults) on the plateau summits and very deep leached soils (Paleustults) on the upper part of side slopes are also extensive.

Potential: The area has high potential for crops and livestock.

## Human Resources

This section gives information about the population, estimated changes in population and population density, demographic trends, and the ethnic groups and tribes of the survey area.

### Population

The 1968 census showed a population of 1,266,816 in the survey area. Generally, the northern part is the most densely populated, and the southern part is the least populated. The size of the divisions within each department, the total population and population density for each division, and the projected changes in population and population density through 1980 are presented in table 4.

The population is increasing at an annual rate of 1.2 percent; it is increasing at a faster rate in the northern part than in the southern part. For example, the population in the Mandara Mountains is increasing at a rate of 2.5 percent, the Foulbe population is stable, and the population is decreasing in the Poli area.

The rate of increase or decrease in population among various tribes is shown in table 5.

TABLE 4.--Population and density

[Density means persons per square kilometer. Population figures for 1974 and 1980 are estimates based on the 1968 national census]

| Department | Division | Area | 1963 | | 1968 | | 1974 | | 1980 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Population | Density | Population | Density | Population | Density | Population | Density |
| | | Sq km | | | | | | | | |
| Benoue 1/ | Garoua | 13,614 | 72,806 | 5.34 | 88,357 | 6.50 | 94,912 | 6.97 | 101,956 | 7.48 |
| | Guider | 4,162 | 118,506 | 28.50 | 127,694 | 30.68 | 136,953 | 32.90 | 147,114 | 35.34 |
| | Poli | 5,600 | 35,036 | 6.25 | 30,888 | 5.51 | 33,774 | 6.03 | 36,930 | 6.59 |
| | Tchollire | 32,021 | 39,011 | 1.21 | 55,560 | 1.73 | 60,758 | 1.89 | 66,428 | 2.07 |
| Diamare | Maroua | 3,142 | 129,309 | 41.15 | 138,138 | 43.96 | 148,387 | 47.22 | 159,396 | 50.73 |
| | Kaele | 2,833 | 97,610 | 34.45 | 112,092 | 39.56 | 120,408 | 42.50 | 129,342 | 45.65 |
| | Mindif | 2,200 | 43,476 | 15.34 | 46,592 | 21.17 | 50,048 | 22.74 | 53,762 | 24.43 |
| | Bogo | 993 | 32,106 | 32.33 | 33,572 | 33.80 | 36,062 | 36.31 | 38,738 | 39.00 |
| | Meri | 530 | 35,644 | 67.25 | 36,084 | 68.08 | 38,761 | 3.13 | 41,637 | 78.56 |
| Margui-Wandala | Mokolo | 4,393 | 180,986 | 41.20 | 205,341 | 46.74 | 220,576 | 50.21 | 236,941 | 53.93 |
| | Mora | 2,736 | 111,566 | 40.77 | 124,156 | 45.37 | 133,367 | 48.74 | 143,262 | 52.36 |
| Mayo-Danai | Yagoua | 3,664 | 109,431 | 29.87 | 122,815 | 33.52 | 131,927 | 36.00 | 141,715 | 38.68 |
| | Kar-Hay | 1,305 | 45,880 | 35.16 | 48,795 | 37.39 | 52,415 | 40.16 | 56,304 | 43.14 |
| Logone-Chari | Makari | 3,664 | 54,950 | 15.00 | 67,356 | 18.38 | 72,353 | 19.74 | 77,721 | 21.21 |
| | Kousseri | 4,969 | 22,872 | 4.60 | 31,248 | 6.28 | 33,566 | 6.75 | 36,056 | 7.25 |

1/ The 1968 census indicated an average annual rate of increase of 1.2 percent in the 1974 and 1980 population of the North Benoue region and 1.5 percent for the South Benoue region.

TABLE 5.--Demographic trends

[The symbol > means more than; < means less than]

| Groups | Tribes that have a population that is-- | | | |
|---|---|---|---|---|
| | Decreasing (>0.5 percent) | Stationary (Decrease of <0.5 percent, increase of >0.4 percent) | Increasing | |
| | | | Slowly (0.5 percent to 1.5 percent) | Rapidly (>15 percent) |
| Islamic---------- | ----- | Foulbe | Arab-Choa | -------- |
| | ----- | Mandara | --------- | -------- |
| | ----- | Kotoko | --------- | -------- |
| Mountain tribes-- | Fali | Kapsiki | Mofou | Mafa |
| | ----- | Meira | Daba | -------- |
| | ----- | Goude | --------- | -------- |
| Plains tribes---- | ----- | Guidar | Mondang | Guiziga |
| | ----- | ------- | --------- | Toupouri |
| | ----- | ------- | --------- | Massa |

## Great ethnic diversity

Five ethnic groups and more than 50 distinct tribes inhabit the survey area.

Population is unequally divided among the ethnic groups, and within each group the distribution is again uneven. Table 6 gives population distribution by ethnic group and by tribe within each group.

## Livestock Resources

In this section, the numerical importance of different livestock species in the survey area is discussed, and ruminant livestock are classified by socio-ecological type.

There are more than one million head of cattle in the survey area, or about 40 percent of the national total. Average cattle density is 1 animal for every 3.5 hectares. Average annual meat production is about 12 kilograms per person, but consumption is poorly distributed.

The kinds and breeds of domestic animals in North Cameroon reflect the harsh environment and the background, traditional values, and expressed socio-economic needs of the people. The livestock industry, because of its diversity and dynamic nature, and the practice of seasonal migration, cannot be evaluated in isolation, but measured generalizations can be made. Despite the lack of information about the industry, however, reasonably valid assessments can be made by comparing animal breed-types and management practices to those of other better known production systems in the same and other related ecological zones.

The livestock industry in North Cameroon is on a subsistence production level. Traditionally, the herdsmen, who either are nomads who keep cattle as a way of life or villagers who keep them as an adjunct to agriculture, raise livestock without significant capital investments except in their animals. Milk is basic to human survival, and beef from surplus animals is secondary. Sheep and goats, however, generally are not raised to provide milk; instead they supply meat for consumption. Their economic importance is minor compared to that of cattle. Many people live at a subsistence level on this relatively small, per capita, number of animals, but they do so at the expense of a deteriorating land resource base.

Production of livestock for subsistence is found in all other sub-Sahara countries at the same ecological latitude. Also, management and animal breed-types rarely differ throughout central West Africa.

Ecologically, North Cameroon is better suited to cattle than to sheep or goats. Cattle are well suited to nomadism, because they can thrive in different ecological belts, and they are large enough to provide needed transport. They can also contribute to balanced agriculture where grazing is available or when they are used as draft animals.

Sheep and goats, however, are also significant in the general socio-economic structure of the region, particularly in certain subregions. If their numbers are properly balanced according to available basic feed resources, they complement one another because they have different grazing habits and space requirements.

TABLE 6.--Ethnic diversity

| Groups | Percent of total population | Tribes | Percent of population within group |
|---|---|---|---|
| Islamic | 34.5 | Foulbe | 59.6 |
| | | Arab-Choa | 11.6 |
| | | Mousgoum | 9.0 |
| | | Bornouan | 8.9 |
| | | Kotoko | 6.1 |
| | | Mandara | 3.8 |
| | | Gamergou, Haoussa, and Mbororo | 1.0 |
| Plains People | 23.5 | Toupouri | 33.0 |
| | | Massa | 30.0 |
| | | Guiziga | 21.0 |
| | | Moundoung | 12.0 |
| | | Mambay and Moussey | 4.0 |
| Mountain People | 19.5 | Mafa and assimilated tribes 1/ | 46.1 |
| | | Mora Mountain 2/ | 33.0 |
| | | Mofou | 20.9 |
| Highland People | 15.5 | Fali | 24.0 |
| | | Guidar | 23.0 |
| | | Kapsiki, Bana, and Djimi | 22.0 |
| | | Daba | 18.0 |
| | | Goude and Njeon | 13.0 |

TABLE 6.--Ethnic diversity--Continued

| Groups | Percent of total population | Tribes | Percent of population within group |
|---|---|---|---|
| South Benoue People--- | 7.0 | Doayo---------- | 45.7 |
| | | Lakka-Lame---------- | 20.3 |
| | | Mboum and Alantika---------- | 15.2 |
| | | Dourou---------- | 14.8 |
| | | Baya---------- | 4.0 |

1/ Hide, Mineo, and Mabass tribes.

2/ Includes all the ethnic groups living within the mountain area.

Sheep are used by Moslems for ritual slaughter. They are easily herded and are well adapted to either migratory or sedentary management systems. Under nomadism, however, sheep must be kept with larger animals that can provide needed herder transport. Major limitations to the raising of sheep are their susceptibility to parasitism and pneumonic diseases in humid climates and their sensitivity to environmental change.

Goats are natural browsers and are tough and adaptable. Their presence indicates a land resource base degraded by poverty and population pressure. Also, goats are hard to displace where conditions have favored their multiplication at the expense of cattle and sheep.

## Numerical importance of livestock

The numerical importance of livestock within each production region is presented in Table 7. Because of seasonal migrations and difficulties in obtaining precise data on the livestock population in the northern region, the figures are estimates. Discussions on livestock are chiefly limited to ruminant species, including cattle, sheep, and goats. Horses are mainly a status symbol, donkeys are used for short-haul load carrying, and pigs are important only for use in rice production.

Total livestock population is 2,593 million head. Of this figure, cattle make up 36.6 percent; goats, 33.4 percent; sheep, 27.0 percent; donkeys, 2.3 percent; and horses and pigs, 0.3 percent each.

The concentration of the total livestock population is 8.9 percent in the northern production region, 74.2 percent in the central region, and 16.8 percent in the southern region.

## Classification of ruminant livestock

No standard lexicon is published that permits a satisfactory classification of the livestock in North Cameroon, because most advanced vocabularies of animal husbandry evolved as specialized breeds were developed, especially breeds of European lineage.

All livestock in the survey area are of a nonspecialized or subsistence type, their primary purpose being support of subsistence producers. Thus, a new concept of type of livestock is needed. Also, the term "breed" must be modified to accommodate further divisions within the various species, because there are no "true" livestock breeds, in the classical sense, within North Cameroon.

Because type and breed are not appropriate terms for classification of livestock in North Cameroon and because the singular functional difference among species of livestock is their adaptability to different environmental conditions, the term eco-type (ecological type) is used in this report for classification within species. Moreover, because major divisions within species generally coincide closely with geographical boundaries or owe their vernacular names to tribal backgrounds, the term tribal breed is used for subdividing genetically exclusive populations within eco-types. This classification system, although it is far from perfect and is better suited to sheep than cattle, does permit a logical discussion of livestock in North Cameroon.

TABLE 7.--Estimated livestock population, 1975

[Estimates based on available data]

| Production region | Cattle | Goats | Sheep | Donkeys | Horses | Pigs | Total | Percent |
|---|---|---|---|---|---|---|---|---|
| Northern | 160,000 | 43,000 | 26,000 | 1,085 | 865 | ----- | 230,950 | 8.9 |
| Central | 580,000 | 698,000 | 580,000 | 52,100 | 7,165 | 8,190 | 1,925,455 | 74.2 |
| Southern | 210,000 | 125,000 | 94,000 | 6,230 | 1,075 | 410 | 436,715 | 16.8 |
| Total | 950,000 | 866,000 | 700,000 | 59,415 | 9,105 | 8,600 | 2,593,120 | 99.9 |
| Percentage of total | 36.6 | 33.4 | 27.0 | 2.3 | 0.3 | 0.3 | 99.9 | |

A special problem encountered in classifying subsistence livestock is a lack of purity caused by cross breeding at both the eco-type and tribal breed levels. Such livestock can best be referred to as intermediate types or tribal-breed crosses. The minimum test for correctness of tribal-breed groupings within a given eco-type is based on the ability of a somewhat experienced individual to identify a herd or flock as belonging to a specific tribe, locality, or place of origin.

The classification of cattle, sheep, and goats by eco-type and tribal breed follows.

1. Cattle
    a. Trypano-susceptible
        1) Zebu (humped), Bos indicus
            a) Choa Arab or Wahdara
            b) M'Bororo Fulani or Rahaji
            c) Foulbe
        2) Taurine (humpless), Bos taurus
            a) Kurt, Buduma, or Lake
    b. Trypano-tolerant
        1) Taurine (humpless)
            a) Kapsiki
            b) Poli
2. Sheep
    a. Deserto-Sahel
        1) Zaghawa
        2) Ouda
        3) Arab
    b. Sudan-Guinea crossbred
        1) Choa Arab
        2) Foulbe
    c. Equatorial and Kirdi enclave
        1) Kotoko
        2) Rain Forest Dwarf
3. Goats
    a. Desert-Sahel
        1) Zaghawa
        2) Foulbe
        3) Arab
    b. Sudan-Guinea crossbred

## Soil Resource Units for Divisional Planning

The nine resource areas in North Cameroon were discussed in the section "Resource Areas for Regional Planning." The resource areas are broad in extent. Geographically associated areas within the resource areas have been mapped in greater detail. These are called soil resource units.

A map showing the resource areas and soil resource units of North Cameroon accompanies this resource inventory; the soil resource units are described in this section. The descriptions, together with the map, can be useful in determining the potential of the resource units, in planning land use, and in developing the resources at the division level. This section also discusses soil properties affecting land use and classifies the soil resource units of North Cameroon.

A soil resource unit represents a natural association of soils on the landscape and consists of one or more component soils. The component soils can have contrasting potentials, and a soil resource unit can include minor areas of soils that are dissimilar in potential to the component soils. Some of these minor areas with dissimilar potentials are as large as several thousand hectares. Thus, the soil resource unit map should be used only for general planning. For detailed planning of individual tracts, a more detailed soil and range site map of a larger scale and onsite investigations are needed.

## Description and potential of soil resource units

General facts about each soil resource unit and a brief description of its component soils are given in this section. Major limitations to use of the soils for crops and the potential of the soils for particular crops are briefly discussed. Each soil resource unit is numbered, and that number identifies the unit on the soil unit map.

Table 8 gives the potential of each soil resource unit for use as rangeland and cropland. The potential applies to 50 percent or more of the unit.

The potential of the component soils of each resource unit for specific crops is given in the section "Agronomy" (see table 24).

### Soil resource unit 1--Lake Chad shore deposits

This soil resource unit comprises 177,300 hectares distributed over the length of an intricate shoreline. The area is a gently sloping, variously inundated lake flood plain that is crosscut by major floodways. It is downslope from a somewhat continuous dune deposit, the "cordon." The component soils are not homogenously associated, and their areas vary in size.

Natraqualfs, flooded, make up 50 percent of this unit. They are mainly in convex interstream areas, inland from Lake Chad, where drainage is impaired by dune deposits. Most areas are near Makari and to the east. These soils are moderately deep, gently sloping, and somewhat poorly drained. They have a thin, loamy surface layer that is eroded in many places, and a thick, massive, very hard, clayey subsurface layer in which there is sufficient accumulation of sodium to restrict root growth. These soils are flooded frequently for brief periods during the wet season. They are used mostly for pasture and have little potential for crops.

Tropaquepts, flooded, make up 40 percent of this unit. These soils formed in lake shore and deltaic deposits. They are deep, gently sloping, and somewhat poorly drained. They have a leached, sandy surface layer that has moderate permeability and moderate available water capacity. The soils are flooded by the lake once every 2 to 4 years. The floods are of long duration. The shoreline shifts, but the soils that are immediately adjacent to the water's edge have good potential for maize. Those further from Lake Chad have good potential for wet-season sorghum and vegetables.

The very deep, droughty sands on dune crests and the clayey soils in frequently flooded basins make up 10 percent of this unit.

### Soil resource unit 2--Sodic crests and wet depressions

This soil resource unit comprises 322,700 hectares and includes the deltaic channels of the Logone-Chari River system west and northwest of Kousseri: the El Beid, Serbeouel and Chari terminal channels. The soils are associated in a pattern perpendicular to regional drainage channels.

Terraces on steep slopes in the Mora-Meri area.

Grass, water, and good grazing management can increase beef production in North Cameroon, as proved at the Wakwa Experiment Station near Ngaoundere. A rotation grazing system helped produce a 160-kilogram animal weight gain per hectare.

A mountainous area between Mora and Mokolo. The population density in these areas is about 275 people per square kilometer. The shallow, stony, and steep soils are intensively used.

A sorghum field near Maroua.

TABLE 8.--Potential of soil resource units for rangeland and cropland

| Map symbol | Soil resource unit | Rangeland | Cropland | | | | |
|---|---|---|---|---|---|---|---|
| | | | Rainfed rice | Other wet-season crops | Dry-season sorghum | Irrigated | |
| | | | | | | Rice | Other crops |
| 1 | Lake Chad shore deposits | Very low | Low | Low | Low | Low | Medium. |
| 2 | Sodic crests and wet depressions | Very low | Medium | Very low | Medium | Medium | Low. |
| 3 | Wet soils in broad depressions | Very high | Very high | Very low | High | Very high | High. |
| 4 | River levee deposits | Low | Low | Low | Low | Low | Medium. |
| 5 | Vertic alluvial plains | Medium | Very high | Very low | Very high | Very high | Low. |
| 6 | Floodways and alluvial fans | Medium | High | Very low | Very high | Very high | Low. |
| 7 | Sodic soils | Very low | Low | Low | Low | Low | Low. |
| 8 | Eroded sodic and vertic soils | Low | Very low | Very low | Very low | Very low | Very low. |
| 9 | Loamy soils overlying ironstone layers. | Medium | Low | Medium | Low | Low | Low. |
| 10 | Low sandy eolian terraces | Medium | Very low | Medium | Very low | Very low | Low. |
| 11 | Dunes and depressions | Medium | Low | Medium | Low | Low | Low. |
| 12 | Undulating vertic uplands | Medium | Low | High | Medium | High | Low. |
| 13 | Level vertic lowlands | Medium | High | Very low | Very high | Very high | High. |
| 14 | Foot slopes and outwash deposits | Low | Very low | Low | Very low | Very low | Low. |
| 15 | Shallow plateau soils and steep mountain slopes. | High | Very low | Low | Very low | Very low | Very low. |
| 16 | Terraced mountain slopes | Low | Very low | Very low | Very low | Very low | Very low. |
| 17 | Sandy soils on uplands | High | Very low | Medium | Very low | Very low | Low. |
| 18 | Sandy soils and rocky hills | Medium | Very low | Low | Very low | Very low | Low. |
| 19 | Sodic and vertic soils on lowlands. | Very high | High | Very low | Medium | High | High. |

TABLE 8.--North Cameroon--Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20 | River deposits---------- | Very high-- | Medium----- | Very low--- | Medium----- | Medium----- | Medium. |
| 21 | Claypan soils on lowlands--------- | Medium----- | Low-------- | Medium----- | Medium----- | High------- | High. |
| 22 | Shallow upland soils---------- | Medium----- | Very low--- | Low-------- | Very low--- | Very low--- | Low. |
| 23 | Hill and valley complex---------- | Medium----- | Low-------- | Low-------- | Low-------- | Low-------- | Low. |
| 24 | Very deep sandy uplands---------- | High------- | Very low--- | Medium----- | Very low--- | Very low--- | Low. |
| 25 | Gravelly soils on sloping uplands- | Medium----- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 26 | Steep mountain slopes---------- | Medium----- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 27 | Stony steep plateau borders------- | Medium----- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 28 | Plateau upper slopes---------- | High------- | Very low--- | Medium----- | Very low--- | Very low--- | Low. |
| 29 | Plateau summits---------- | High------- | Very low--- | High------- | Very low--- | Very low--- | Medium. |

Natraqualfs, flooded, make up 35 percent of this unit. They are on interstream crests and are moderately deep, gently sloping, and somewhat poorly drained. They have a thin, loamy surface layer that is eroded in many places and a thick, massive, very hard clayey subsurface layer that is dominated by an accumulation of sodium. These soils are frequently flooded for brief periods during the wet season. They are used mostly for pasture and have little potential for crops.

Pellusterts, flooded, make up 30 percent of this unit. They are in linear drainage courses that carry channel overflow during flooding. These soils are very deep, nearly level, and poorly drained. They are very clayey throughout, and the soil horizons are indistinct. These soils are very slowly permeable when wet, have high shrink-swell potential, and develop wide, deep cracks during the dry season. They have a very high potential for dry-season sorghum and for localized rice farming. These soils are suited to pasture because of high fertility and high available water capacity.

Isolated crests of rarely flooded clayey and sodic soils and elongated, ancient riverbeds that are saturated for most of the year make up 35 percent of this unit.

Soil resource unit 3--Wet soils in broad depressions

This soil resource unit comprises 243,200 hectares and includes the region traditionally termed the "Grand Yaere." The unit is in the central part of the Logone alluvial plain and extends from just north of Pouss to just south of Kousseri. The area is a very broad depression that serves as a regional watercourse from tropical and equatorial regions to the Lake Chad Basin. Rainfall and flooding are almost continuous for 6 or 7 months annually, and during this time flooding reaches a maximum height of 80 to 120 centimeters in areas of typical relief. During the rest of the year this area is totally without rainfall.

Tropaqualfs, flooded, make up 90 percent of this unit. They are very deep, very poorly drained soils in broad, closed depressions. These soils have a thick, light clay surface layer and a thicker, heavy clay subsurface layer that is very slowly permeable and has moderate shrink-swell potential. These soils transmit water very slowly and are continuously saturated below a depth of 50 to 100 centimeters. They are the survey area's largest area of relatively undisturbed land. These soils have potential for development only as part of the management of the entire Logone Plain. Border areas are used for dry-season sorghum and rainfed rice. The soils have very high potential for rice if there is suitable water management.

Vertic clayey soils in the upper part of depressions and clayey marsh soils in continuously flooded, deep depressions make up 10 percent of this unit. The marsh soils have a high content of organic matter.

Soil resource unit 4--River levee deposits

This soil resource unit is not extensive--86,300 hectares--but it is important because of its distribution in long, narrow areas on both banks of the Logone River. It consists of a series of natural deposits adjacent to the active channel and includes buttes and levees. People have settled here permanently because these are the highest areas on the entire alluvial plain.

Fluvaquents make up 60 percent of this unit. These soils are on rounded, uneven landforms. They are gently sloping, very deep, somewhat poorly drained, and have stratified layers of loam and sand that lack a definite pattern. They are commonly underlain by gravelly layers. The soils are moderately permeable and have a moderate available water capacity. These soils are rarely flooded, although they are transected in many places by lateral tributary channels. They are used mainly for wet-season crops, including sorghum and vegetables. Land-use problems include controlling erosion and maintaining fertility.

Fluvaquents, flooded, make up 25 percent of this unit. These soils are in crosscuts of active floodways and on the lower part of levees. They have stratified layers that are sandy in most places but are loamy and clayey in others. The soils are saturated to the surface for about 6 months out of the year and are saturated below a depth of 60 centimeters throughout the year. They are inundated for long periods during 4 to 8 months of the year. The soils are extensively used for pasture during the dry season, but production is low. The soils that have a clayey subsurface layer have high potential for rice.

Sodic soils in lateral bands on both sides of levees and vertic, clayey soils in small basins make up 15 percent of this unit.

Soil resource unit 5--Vertic alluvial plains

This soil resource unit comprises 141,200 hectares in large, uniform areas in the Yaere Alluvial Plains resource area, principally in the vicinity of Waza. It is mainly a nearly level, featureless plain.

Pellusterts, flooded, make up 80 percent of this unit. These soils are on upper side slopes of the broad alluvial plain of the Logone River. They are very deep, nearly level, and poorly drained. They are very clayey throughout, and the horizons lack distinct differentiation. The soils are very slowly permeable when wet, have a high shrink-swell potential, and develop deep, wide cracks during the dry season. They are flooded for 3 to 5 months out of the year but are the first soils to be drained when floodwater recedes. They have a very high potential for dry-season sorghum and for rice. These soils are suited to pasture because of their high fertility and high available water capacity.

About 20 percent of this unit consists of a few elongated sandy dune deposits and nearly continuously saturated clayey soils in shallow basins.

Soil resource unit 6--Floodways and alluvial fans

This soil resource unit comprises 415,000 hectares and is widely distributed. It is in the Yaere Alluvial Plains and Diamare Plains resource areas. This unit parallels the Logone River in North Cameroon. The most extensive area is west of Pouss on the broad alluvial plain of the Logone River. The unit is also in the Yagoua area, where the Mayo Guerleo floodway conducts runoff water to the Logone River in times of normal streamflow; some water flows in the opposite direction during the flood stage. South of Yagoua, the Dania Fianga floodway has a similar drainage relationship to the Benoue River watershed.

Pellusterts, flooded, make up 45 percent of this unit. These soils are along the outside border of floodways. They are very deep, nearly level, and poorly drained. The soils are very clayey throughout and lack distinct horizon differentiation. They are very slowly permeable when wet, have high shrink-swell potential, and develop wide, deep cracks during the dry season. These soils are flooded for 4 months of the year. They have very high potential for dry-season sorghum and for rice. The soils are suited to pasture because of high fertility and high available water capacity.

Fluvaquents, flooded, make up 40 percent of this unit. These soils are in accessory channels on the broad alluvial plain of the Logone River and in depressed interdune areas. The soils are deep, level to depressed, and very poorly drained, and their properties vary within short distances. The soils are stratified. Most layers are sandy, but some are loamy and clayey. These soils are saturated throughout for about 6 months of the year and are saturated below a depth of 60 centimeters throughout the year. They are flooded for long periods during 4 to 8 months of the year. The soils are used extensively for pasture, but production is low during the dry season. Where these soils have a clayey subsurface layer, they have high potential for rice. A large acreage of such soils is north of Yagoua and north and west of Pouss.

Isolated sandy spots that are above flood level and elongated marshy channels that are continuously flooded make up 15 percent of this unit.

Soil resource unit 7--Sodic soils

This soil resource unit comprises 381,800 hectares and is widely distributed throughout the Diamare Plains. It is mostly on foot slopes adjacent to granitic hills. Some areas are on broad plains where there is year-round seepage. The component soils of this unit are intricately mixed.

Natraqualfs make up 60 percent of this unit. Most areas are ponded by ground water that seeps laterally from granitic uplands. The soils are moderately deep, gently sloping, and moderately well drained. They have a thin, strongly leached, loamy surface layer and a thick, massive, clayey subsurface layer that has very slow permeability and is very hard and strongly cemented. Sodium makes up 15 to 30 percent of the total content of bases and is difficult to remove. These poorly structured soils are locally called "sols hardes." Production of cotton and sorghum is feasible only after deep tillage.

Tropaquents make up 20 percent of this unit. These soils are in short drainageways that receive runoff from the adjacent hills. The soils are very deep and poorly drained. They are loamy and moderately permeable and are stratified in some places. A temporary water table is at a depth of about 100 centimeters during the 4-month wet season. The soils have low potential for wet-season crops, medium potential for dry-season sorghum, and high potential for rice.

Soils that are similar to the Natraqualfs but are severely eroded, some vertic clayey soils, and frequently flooded alluvial soils make up 20 percent of this unit.

Soil resource unit 8--Eroded sodic and vertic soils

This soil resource unit comprises 284,400 hectares on the Diamare Plains. It is on the upper part of foot slopes of hills and mountains. Runoff causes severe erosion and gullying. The soils in this unit are associated with uneroded sodic and vertic soils.

Natraqualfs, eroded, make up 40 percent of this unit. These soils are moderately deep, gently sloping, moderately well drained, and severely gullied. The surface horizon has been eroded, and the indurated, clayey subsurface layer is exposed. These soils cannot be hand cultivated and have very low potential for crops.

Pellusterts, eroded, make up 35 percent of this unit. These soils are moderately deep, gently sloping and moderately sloping, and well drained. They are severely eroded. The exposed subsurface layer is gravelly clay. It is very slowly permeable and has very poor structure. These soils do not store enough water for dry-season sorghum. They have very low potential for wet-season sorghum because their low fertility results in poor seed germination.

Uneroded sodic and vertic soils in small areas make up 25 percent of the unit.

Soil resource unit 9--Loamy soils overlying ironstone

This soil resource unit is not extensive--70,100 hectares--and is mainly in the Mindif-Kaele area. This unit consists of gently undulating, broad upland crests and shallow depressions. The soils are moderately deep and are abruptly underlain by buried, truncated ironstone layers.

Sodic soils near Kaele.

Terraced mountain slopes north of Mokolo, after harvest.

Haplustalfs, moderately deep, make up 40 percent of this unit. These soils are on broad upland crests on open plains. They are moderately deep and well drained. They have a thin, loamy surface layer and a clayey subsurface layer that is slowly permeable. Outcrops of the underlying ironstone are common. These soils are low in fertility and are eroded in many places. They have medium potential for crops and pasture.

Tropaqualfs, depressed, make up 30 percent of this unit. These soils are in slight depressions. They are moderately deep, nearly level, and somewhat poorly drained and have a thin, loamy surface layer. The subsurface layer is clayey and very slowly permeable; it abruptly overlies ironstone. The soils have a perched water table in lower layers during periods of rainfall. Many areas are cultivated. These soils have medium to low potential for crops.

Soils that are similar to the major soils in this unit, except that they are shallow over hardened ironstone, and vertic clayey soils in long, narrow areas in basins make up 30 percent of this unit.

## Soil resource unit 10--Low sandy eolian terraces

This soil resource unit is moderately extensive and comprises 245,500 hectares. It consists of wind-formed "cordon" deposits in the regional basin of the Logone River. These deposits form large, broad ridges on lateral, low terraces where wind action has caused an aggradation of fine sandy sediment. The soils in the unit occur in irregular patterns on the landscape.

Ustropepts make up 60 percent of this unit. These soils are on broad crests of old dunes. They are deep, gently sloping, and somewhat excessively drained and have a thick sandy surface layer. The subsurface layer is sandy. It is rapidly permeable and has low available water capacity. The soils are easily tilled and have good drainage. Limitations to their use are low available water capacity and low fertility. The soils have medium potential for crops and pasture, but few areas are cultivated.

Tropaquents make up 25 percent of this unit. These soils are in somewhat broad, shallow depressions that receive excess runoff from adjacent areas in periods of rainfall. The soils are very deep, loamy, moderately permeable, and poorly drained. A seasonal high water table is at a depth of 50 to 150 centimeters during the wet season. The soils have very low potential for wet-season crops, medium potential for dry-season sorghum, and high potential for rice.

Moderately sloping, eroded Ustropepts and soils in natural drainageways that are saturated for long periods make up 15 percent of this unit.

## Soil resource unit 11--Dunes and depressions

This soil resource unit comprises 307,800 hectares and is well distributed throughout the Bogo-Yagoua section of the Diamare Plains. It consists of dunes and interdune depressions. The soils in this unit occur in a cyclic pattern of long, narrow areas oriented in a northeast-southwest direction.

Ustropepts make up 40 percent of this unit. These soils are on elongated, wind-formed dunes that have gently rounded crests. The dunes are stratified old landforms, and the hazard of wind erosion is slight. The soils are deep, gently sloping, and somewhat excessively drained. They have a thick, sandy surface layer. The subsurface layer is sandy, rapidly permeable, and has low available water capacity. These soils have medium potential for wet-season crops.

Tropaquents, flooded, make up 35 percent of this unit. These soils are in parallel, elongated depressions that are between dunes. Because the outlets of most of the depressions are blocked, the soils have a high water table for much of the rainy season and are flooded for about 3 months. The surface layer is thick and loamy, and the subsurface layer is slightly more clayey and is slowly permeable. These soils are very poorly drained. They have high potential for rice in small plots and medium potential for pasture. The main limitations are frequent flooding and saturation for long periods.

Eroded Ustropepts, clayey vertic soils in small areas, and soils in narrow floodways of streams make up 25 percent of this unit.

## Soil resource unit 12--Undulating vertic uplands

This soil resource unit comprises 320,600 hectares and is widely distributed in the Diamare Plains. Large areas are in the vicinity of Kaele, northeast of Guider, and north and northeast of Garoua. The component soils have slightly undulating slopes of medium length. They generally occur in a uniform pattern on interfluvial crests and on the lower part of foot slopes. Relief is hilly.

Chromusterts make up 50 percent of this unit. The areas generally are large. The soils are on convex, broad hillcrests. They are clayey, moderately deep, gently sloping, and moderately well drained. They are slowly permeable when wet and have high shrink-swell potential. Horizons are weakly differentiated. Deep cracks develop in the dry season. In some areas the soils are gravelly and eroded. Because drainage is good, these soils have high potential for cotton production and medium potential for dry-season sorghum. They have good capacity for water storage but lack optimum depth. They are highly susceptible to sheet erosion.

Pellusterts make up 25 percent of this unit. These soils are on the lower part of foot slopes. They are clayey, deep, nearly level, poorly drained, and very slowly permeable when wet. Soil horizons are weakly expressed. The soils have high shrink-swell potential. Wide, deep cracks form as the dry season progresses, although the soils remain wet for several months after the wet season ends. The soils have high to very high potential for dry-season sorghum and irrigated rice.

Rockland, shallow stony soils near Guider, and deep ferruginous soils east of Garoua make up 25 percent of this unit.

## Soil resource unit 13--Level vertic lowlands

Though this soil resource unit is not extensive, comprising only 214,300 hectares, it is an important land resource and is widely distributed in the Diamare Plains. Sizable areas of this unit are in the vicinity of Maroua and northeast of Mora. The component soils typically occupy old alluvial basins on uplands of very gentle relief. The soils lack uniformity.

Pellusterts make up 70 percent of this unit. These soils are in broad, level to depressed areas at the upper border of the regional Logone Basin. They are deep, nearly level, poorly drained, and very slowly permeable when wet. These soils are clayey and have a high shrink-swell potential. Horizons lack differentiation. Wide, deep cracks develop as the dry season progresses, although the soils remain wet for several months after the wet season ends. They are saturated near the surface for long periods and are briefly flooded by runoff during storms. These soils have high to very high potential for dry-season sorghum and irrigated rice if they are fertilized with nitrogen. In some areas that have better drainage, cotton can be grown.

Chromusterts make up 15 percent of this unit. These are gently sloping soils on foot slopes that border broad basins. They are clayey, moderately deep, and moderately well drained. The soil horizons are weakly differentiated. The soils are slowly permeable when wet and have high shrink-swell potential. Deep cracks develop during the dry season. Because drainage is good, these soils have high potential for cotton and medium potential for dry-season sorghum.

Spots of sodic soils at slightly higher elevations, eroded vertic clayey soils, and clayey soils that are flooded for long periods make up 15 percent of this unit.

## Soil resource unit 14--Foot slopes and outwash deposits

This soil resource unit comprises 156,100 hectares and is distributed widely in mountainous areas of the Mandara Highlands and the mountains near Poli. The component soils formed in downwash deposits transported by rapid runoff and in interior valley outwash deposits. They are on foot slopes and in basins.

Ustifluvents make up 35 percent of this unit. These soils formed in deposits on the outwash plains of local streams. They have gentle slopes, are very deep and somewhat excessively drained, and have stratified sandy and loamy layers that are rapidly permeable. Gravelly layers are common in the lower part of the profile. The original woodland vegetation has been cleared, and the sites are now cultivated. These soils have medium potential for wet-season crops. Yields are moderate if they are protected from flooding.

Ustipsamments make up 25 percent of this unit. These soils are typically on narrow colluvial foot slopes that are commonly incised by natural drainageways that were formed by runoff from hillsides. They are very deep, moderately sloping, and excessively drained. The soils are thick deposits of coarse sand, and soil horizons are weakly differentiated. Rocks are common in and on the soil, and boulders are common in some places. These soils are intensively cropped with wet-season sorghum. They have low to medium potential for crops. These soils are easy to cultivate, but yields are low because of low available water capacity and poor fertility.

Similar soils that are eroded, small spots of sodic soils, and some areas of Rockland make up 40 percent of this mapping unit.

Soil resource unit 15--Shallow plateau soils and steep mountain slopes

This soil resource unit comprises 286,600 hectares and consists of contrasting landforms. An undulating and rolling plateau occurs west of Mokolo and extends south of Rumsiki. Highlands with excessive relief of intricate valleys and massive mountains surround the plateau and extend northeast to Mora and southwest to Dourbeye.

Ustorthents, shallow, gently sloping, make up 45 percent of this unit. These soils are on plateaus of the Mandara Highlands. Some areas are in rolling terrain. The surface soils are loamy and overlie slightly more clayey lower horizons. Stones and gravel make up 20 to 40 percent of the soil by volume. The soils are 20 to 50 centimeters deep over coarse rubble that developed from granite bedrock. They have very low potential for wet-season sorghum and are well suited to grassland.

Ustorthents, shallow, steep, make up 40 percent of this unit. These are stony soils commonly in steep mountainous areas. Typically, they consist of sandy, little altered, soil material in pockets 20 to 70 centimeters thick. They are excessively drained, and a cover of native grass is needed to control erosion. The potential for grazing is low.

Rockland makes up 15 percent of this unit. These areas have excessive relief and include mountain peaks and bare rock on very steep mountain slopes.

Soil resource unit 16--Terraced mountain slopes

This soil resource unit comprises 281,000 hectares in the heavily populated mountainous regions of the Mandara Highlands. These regions are north of Mokolo and extend beyond Mozogo along the Nigerian border; are south of Mora and extend below Meri; and are in the Zamay area to the west.

Ustorthents, shallow, terraced, make up 80 percent of this unit. About 15 to 50 percent of the surface area is exposed rocks or boulders. The soil between rocks contains from 20 to 40 percent coarse fragments. It is usually about 25 centimeters thick, but in some small areas it is up to 100 centimeters thick. For a long time the soils of these steep mountain slopes have been cultivated, all by hand labor. Terraces were constructed by hand and small stones and boulders were removed. The terraces are about 25 centimeters high and range in width from about one meter to several meters. Except where broken by rock outcrops, mountainous ridges are nearly completely terraced. Undoubtedly considerable soil is lost through erosion, and extreme care is required to maintain the productivity of the soils. The most common crop is wet-season sorghum, but peanuts and vegetables are also grown. Where the soils are not terraced, they are best suited for grazing but their potential is low.

Rockland makes up 20 percent of this unit. This component is on very steep mountain slopes and consists of the rough, bouldery summits at the highest elevations. The surface is covered with stones and boulders, and 50 to 80 percent of the surface consists of exposed bedrock. A very thin layer of soil material is between boulders. It is excessively drained, gravelly sand and has low available water capacity. Rockland has very low potential for development.

Soil resource unit 17--Sandy soils on uplands

This soil resource unit comprises 205,200 hectares and is widely distributed in the Lower Benoue Valley mostly on the south side of the Benoue River between hills and wet lowlands. Relief is gentle and consists of long smooth slopes. This unit is hetergeneous, and is made up of similar and contrasting soils.

Paleustalfs make up 60 percent of this unit. These soils are mostly in one large area near the Benoue River border passage. They are very deep, gently sloping, and moderately well drained. They have a thick, sandy surface layer and a thick, moderately permeable subsurface layer in which clay has accumulated. These soils are moderate to low in fertility but have few restrictions to use. They have good potential for wet-season crops including sorghum and peanuts. The hazard of erosion is severe in cultivated areas.

Haplustalfs, deep, make up 20 percent of this unit. They are on the upper part of valley side slopes that are somewhat incised by drainage channels. The soils are mostly deep, moderately sloping, and well drained. They have a thin, sandy surface layer and a thick, loamy subsurface layer that is moderately permeable. These soils have medium potential for a wide variety of wet-season crops if erosion is controlled.

Shallow, stony soils on low hills and wet, loamy and gravelly soils that are overwashed and are saturated for long periods make up 20 percent of this unit.

Soil resource unit 18--Sandy soils and rocky hills

This soil resource unit comprises 200,300 hectares. It is in the area of Cretaceous sandstone outcrop near Garoua and is widely distributed throughout the Lower Benoue Valley. The soils in this unit are similar to those in resource unit 17 except that areas of rock outcrop and hill crests that lack an accumulation of soil material are more numerous. The pattern of soils in this unit is uniform.

Paleustalfs make up 40 percent of this unit. Typically these soils have long smooth slopes. They are very deep, gently sloping, moderately well drained sandy and loamy soils. The soils are similar to the Paleustalfs in soil resource unit 17, and they have similar potential for crops. Where these soils occur with the more shallow soils in this resource unit, they have lower potential for crops and are cultivated in small plots.

Ustropepts, shallow, make up 30 percent of this unit. These soils are in narrow lateral bands on the upper part of steep hillsides. They are shallow, rapidly permeable, and excessively drained. The surface layer typically is thin, stony, and loamy, and the subsurface layer is made up of small pockets of loamy material in a matrix that is dominantly stones and boulders. The main limitation, if stones and boulders are removed, is low available water capacity and a very severe erosion hazard. These soils have low potential for crops and are suitable only for marginal grazing.

Large areas of Rockland, some moderately deep associated soils, and wet soils on foot slopes where seepage occurs after heavy rainfall make up 30 percent of this unit.

Soil resource unit 19--Sodic and vertic soils on lowlands

This soil resource unit comprises 548,000 hectares and is distributed around the perimeter of an alluvial basin. Tributaries of the lower Benoue River typically flow over the level alluvial plain and leave fan-shaped deposits. The flooding results in concentrations of excess water in large areas.

Tropaquents make up 50 percent of this unit. These soils are in large level areas and depressions where sedimentation has blocked the drainageways. The soils are very deep, poorly drained, moderately permeable, and loamy. Some horizons are stratified. A permanent water table is at a depth of about 140 centimeters. The water table is perched within a depth of 35 centimeters for most of a 4-month wet season. These soils have no potential for wet-season crops except for localized rice. They have some potential for grazing, but grazing is limited during the wet season.

Pellusterts make up 30 percent of this unit. These soils are nearly level and slightly elevated above the adjacent flood plains. They are very deep, poorly drained, and clayey. Permeability is very slow, and the shrink-swell potential is very high. These soils have limitations that are typical of long-saturated, vertic, clayey soils, although the available water capacity and fertility are high. These soils are saturated with water during the rainy season, which limits their use. But because they have a high available water capacity and are very fertile, these soils have very high potential for specialized dry-season crops.

Natraqualfs make up 20 percent of this unit. The soils are deep, nearly level, and poorly drained. They occur in bands below hills where excess sodium has concentrated as a result of the evaporation of seepage water. The clayey subsurface horizon is very hard and massive. The soils have low potential for crops and pasture because of the unfavorable soil-moisture relationship, and tillage is very difficult.

Soil resource unit 20--River deposits

This unit comprises 396,500 hectares along the lower main channel of the Benoue River. It is mainly located at the confluence of the Benoue's two main tributaries, the Faro and the Mayo Kebi Rivers. The minor components of this unit are rounded areas of depressed marshland that occur throughout the length of the active flood plain. All of the soils in this unit are flooded occasionally, some briefly and others for long periods.

Ustifluvents, flooded, make up 65 percent of this unit. These soils are on a broad, nearly level flood plain that has some low ridges caused by uneven deposition of sediments. These soils are very deep and somewhat poorly drained and have stratified loamy and sandy layers. Occasional flooding occurs for brief periods during storms. The potential for crops varies widely and depends on the duration of flooding. When flooding is of short duration the potential is good for wet- and dry-season vegetables, peanuts, and sorghum. Yields are moderate.

Pellusterts, flooded, make up 15 percent of this unit. These soils occur mainly at the confluence of the Faro and Benoue Rivers. They are very poorly drained. They are similar to Pellusterts that occur in basins at a slightly higher elevation. These soils are occasionally flooded for long periods. They have very low potential for wet-season crops and very high potential for rice in fringe plantings.

Riverwash sediments and wet, very low bottom-land soils that are flooded for 5 to 6 months make up 20 percent of this unit.

Soil resource unit 21--Claypan soils on lowlands

This soil resource unit comprises 719,200 hectares and is widely distributed in lowlands in the southern and eastern parts of the Intermediate Benoue Valley resource area. Relief is gentle and consists of long slopes between elevated land masses.

Tropaqualfs, gently sloping, make up 65 percent of this unit. These soils are in large areas on interstream divides. They are deep and somewhat poorly drained. The surface layer is thin and loamy. In the subsurface layer, the clay content increases with depth and the shrink-swell potential is moderate. These soils are moderately fertile and resist erosion very well, but they have not been extensively cultivated. They have high potential for use as grassland. The major limitation to use is saturation below a depth of about 50 centimeters during part of the rainy season.

Wet vertic clayey soils, especially in lowlands east of Rey Bouba, and loamy soils that are moderately deep over ironstone layers, in the area northeast and west of the mountains near Poli, make up 35 percent of this unit.

Soil resource unit 22--Shallow upland soils

This soil resource unit comprises 196,500 hectares. It is primarily south and east of Guider and east of Bibemi. The soils are gently sloping to gently rolling and lack incised drainageways. The basic parent material of the soils in this unit weathers very slowly and does not form land masses of high relief.

Haplustalfs, shallow, make up 70 percent of this unit. Areas of these soils are generally large and lack complexity. The soils are shallow, mostly gently sloping, and well drained. They have a very thin, gravelly loam surface layer and a thin clayey subsurface layer that is slowly permeable. Hard bedrock is at a depth of about 45 centimeters. These soils have high fertility, but low available water capacity and a severe erosion hazard are severe limitations to use. They have limited potential for cotton and are best suited to grassland.

Undulating, vertic clayey soils at lower elevations and shallow, stony and gravelly soils on hillcrests make up 30 percent of this unit.

Soil resource unit 23--Hill and valley complex

This soil resource unit comprises 790,900 hectares in the Intermediate and Upper Benoue Valleys. The component soils form a uniform pattern. They occur most commonly on low hills and in somewhat broad valleys in the upper reaches of the Benoue River.

Haplustalfs, deep, make up 40 percent of this unit. These are gently sloping to rolling soils in somewhat large areas on the middle part of side slopes. Typically, they are deep and well drained. They have a rather thin sandy surface layer and a thick loamy subsurface layer. They are moderately permeable. They are eroded in places and are commonly gravelly. These soils are a major resource for diversified cultivation, for which they have medium potential. They are moderately fertile and have moderate available water capacity. Controlling erosion and maintaining fertility are the main concerns of management.

Tropaquepts make up 30 percent of this unit. These soils are in areas downslope from Haplustalfs. Most areas are in lateral bands on foot slopes. Some areas are on confined bottom land that is flooded frequently for brief periods. The soils are deep, gently sloping, and somewhat poorly drained. The surface layer, which typically is altered by erosion and deposition, is sandy or loamy. The subsurface layer is thick, loamy, and slowly permeable. A perched water table is above a depth of 50 centimeters for 4 to 6 months of the year. These soils are excessively wet for about 3 months of the year, mostly because of lateral seepage from adjacent rock outcrops. They are rarely cultivated because of wetness. They have good potential for rice in small plots and border plantings and for pasture. Shallow, stony soils on hill summits and outcrops of rock on side slopes make up 30 percent of this unit.

Soil resource unit 24--Very deep sandy uplands

This soil resource unit comprises 929,600 hectares. It makes up the major part of the Upper Benoue-Logone Valleys resource area. A few areas are in the extreme southern part of the Intermediate Benoue Valley adjacent to a plateau escarpment. There generally are no contrasting landforms. Relief consists of gently sloping to weakly undulating, very broad interfluvial crests and in some places, shallow swales in which sediment has accumulated.

Plinthustalfs make up 70 percent of this unit. These soils are very deep, gently sloping and moderately well drained. They have a sandy or loamy surface layer of medium thickness that contains many concretions of ferruginous gravel. The subsurface layer is thick, loamy, and slowly permeable and contains more than 50 percent "plinthite" fragments in an aggregated mass. These soils are not particularly fertile, but they have medium to high potential for cotton and sorghum if fertilized. They are more resistant to erosion than similar hillside soils and are easily hand-cultivated.

Sandy soils that are moderately deep over indurated layers and lowland soils that are saturated at a shallow depth for several months each year make up 30 percent of this unit. Ironstone layers outcrop at the edges of the incised drainage network. These soils are adjacent to the segment of Mayo Rey, east of Tchollire.

## Soil resource unit 25--Gravelly soils on sloping uplands

This soil resource unit comprises 534,100 hectares and is widely distributed throughout the Intermediate Benoue Valley, especially in the northernmost and southernmost parts. The soils in this unit lack a regular pattern of occurrence, but their potential for crops is similar. Relief commonly is excessive, and the parent materials are hard rock.

Ustropepts, shallow, make up 40 percent of this unit. These are gravelly soils on hills that are deeply dissected by drainageways with moderately steep and steep sides. The soils are shallow to hard rock. They are excessively drained and have sandy and loamy horizons that contain stones and boulders. The parent material in the Garoua area commonly is hardened sandstone. These soils have low potential for cultivated crops and pasture. Sorghum is grown in a few areas where population is concentrated, but yields are marginal and cultivation generally results in accelerated soil erosion.

Ustorthents, moderately deep, make up 30 percent of this unit. These soils are on rolling hills and lower slopes of massive mountains. They are excessively drained, stony and gravelly loamy soils. They generally are moderately deep but commonly range from very shallow to deep within short distances. Parent material commonly is granite and schist; bedrock layers of hardened ironstone occur in some places. The potential of these soils for crops depends on soil depth and slope. Some small plots of these soils are cultivated but the soils are better suited to grazing.

Rockland and a variety of shallow and deep soils, including eroded ferruginous soils and very deep pockets of sandy soils in narrow valleys, make up 30 percent of this unit.

## Soil resource unit 26--Steep mountain slopes

This soil resource unit comprises 495,800 hectares and is located immediately north of the Adamaoua Plateau. It consists of several isolated sections which are mainly singular, massive mountain landforms. These mountains have the highest elevation in the survey area. The mountain peaks range from 1,500 to 2,000 meters in elevation. There are no extensive plateaus.

Ustorthents, shallow, steep, make up 70 percent of this unit. These soils are moderately steep and steep on mountainsides. They occur as a thin mantle of soil material between rocks and boulders. They are excessively drained, stony soils. Typically, the soil material is sandy and unweathered. It occurs in pockets 20 to 70 centimeters thick. A native cover of short grass vegetation adequately protects these soils from erosion. The hazard of erosion is severe on small plots of these soils that are used for sorghum or vegetables. The soils have low potential for grazing.

Rockland makes up 20 percent of this unit. This component is on very steep mountainsides and rough, bouldery summits at the highest elevations. Typically, 50 to 80 percent of the surface layer is fragmented hard rock. Between boulders there is a very thin gravelly sandy soil that is excessively drained and has low available water capacity. Rockland has very low potential for development.

Shallow and moderately deep, less stony, loamy soils in valleys make up 10 percent of this unit. These soils have a slightly clayey subsurface layer and are sometimes flooded.

## Soil resource unit 27--Stony steep plateau borders

This soil resource unit spans the Adamaoua Plateau and marks its northern limit. It comprises 535,000 hectares. The relief is excessive. The resource unit extends from the upper slopes of the tableland to the foot slopes of the escarpment. Slopes are complex, and drainage channels are deeply incised.

Dystropepts make up 40 percent of this unit. These soils occur in small areas on the lower slopes of narrow valleys. The soils consist of fill deposits that are moderately deep over massive, very hard rock. Slopes are strong and the soils are excessively drained and stony throughout. The surface layer is gravelly loam, and the subsoil contains somewhat more clay but is moderately permeable. Although these are the most productive soils in this resource unit, their potential is low because of the limited available water capacity and the severe erosion hazard. Yields of annual crops are marginal.

Ustorthents, shallow, steep, make up 30 percent of this unit. These soils are mostly on midslope positions in an exposed area where little soil material can accumulate. Slopes are moderately steep to steep. The soils are sandy or loamy, excessively drained, and coarsely fragmented. They are shallow, although pockets between rocks can extend to a depth of 70 centimeters. Because of the severe erosion hazard, very low available water capacity, and low capacity to supply nutrients, the soils have low potential for development.

Deep, gently sloping, loamy soils on foot slopes and steep Rockland make up 30 percent of this unit and are useful only as wildlife habitat.

## Soil resource unit 28--Plateau upper slopes

This soil resource unit comprises 392,600 hectares in large areas in the High Plateaus resource area. The topography consists of mostly convex ridges and smooth long slopes that grade into abrupt escarpments. The soils are mostly undulating and gently rolling and are on the broad "second-level" tables of the plateau, where elevation ranges from 800 to 1,000 meters.

Paleustults make up 60 percent of this unit. These soils are mainly in the eastern plateau extensions. They are very deep, undulating, and well drained. They have a thin, loamy surface layer and a thick, reddish, slowly permeable, clayey subsurface layer. Although physical characteristics of these soils are favorable to crop production, yields are poor because there is pronounced leaching of bases. These soils have potential for many uses, including the production of tree fruits, forest products, a broad variety of annuals, and sugar cane and for development as grassland.

Haplustults make up 20 percent of this unit. These soils are in the southern part of the survey area east of Mbe in areas of strongly incised relief. These soils are deep, well drained, and gently rolling. They have a thin, loamy surface layer and a moderately thick, brownish, clayey subsurface layer that is slowly permeable. The soils contain more bases than the Paleustults and are moderately productive. The severe hazard of erosion if these soils are not protected and restricted water movement through these soils are significant limitations to their use. The potential for cultivation is moderate if erosion is controlled.

Similar soils overlying indurated ironstone layers, which commonly outcrop, and strongly sloping, shallow and moderately deep, stony soils make up 20 percent of this unit.

Soil resource unit 29--Plateau summits

This soil resource unit comprises 122,400 hectares in the High Plateaus resource area east of Ngaoundere. Elevation is more than 1,000 meters. Within the tableland of the broad plateau are gently sloping shallow basins in which moisture relations are ideal.

Tropohumults make up 70 percent of this unit. These soils are very deep and well drained. These soils have a thin loamy surface layer and a very thick, slowly permeable, clayey subsurface layer which contains much silt. Generally, the organic-matter content is more than 3 percent in the surface layer. The parent material is commonly basic igneous rock, for example, basalt. These soils have an optimum soil-water relationship and an adequate base content, and they are highly productive. Although these soils in the Adamaoua Plateau have been used mainly for grazing, they have potential for many uses. The hazard of erosion is not a significant limitation, and these soils have high potential for the cultivation of a variety of annual and perennial grasses and woody plants.

Very deep, excessively leached soils in drainageways and moderately deep, steep soils that have outcrops of rock make up 30 percent of this unit.

## Soil properties affecting land use

Table 9 shows estimated soil properties and site features that affect the behavior of the soils for various land uses. These properties and features were considered in rating the potential of the soils for crops in the description of soil resource units (also see table 24 in the section "Potential for Selected Crops").

The estimates are based on available field and laboratory data and some data that have not been previously published. Terms used in column headings and as entries in columns are defined in the Glossary.

## Classification of soils

The soils were first classified to compare their significant characteristics and to organize the facts that are known about each dominant soil type. This procedure showed the relationship of one soil to another and to the whole environment and provided an understanding of soil behavior. In this way alternative uses could be planned and responses to management could be predicted.

To make effective use of the soil data in this report, it is recommended that (1) the classification be studied, (2) the soil resource map be used to relate soil potentials and limitations to geographic locales, and (3) the knowledge from research and experience be applied to specific problems or project plans.

The taxonomic system used in developing the resource map and the mapping unit legend is taken from Soil Taxonomy, Agriculture Handbook No. 436, United States Department of Agriculture. This system is used throughout the United States and in many other countries. It defines soil classes in terms of observable or measurable properties. The properties chosen are mainly those that permit grouping of soils that are similar in genesis. Genesis, or mode of soil origin, does not appear in the definition of the classes; it lies behind the classes. The system employs a nomenclature that is essentially connotative. A full explanation of the classification system, however, is beyond the scope of this resource inventory.

In this survey, the placement and naming of soil units make use of three levels of classification. Beginning with the most inclusive, the categories allow for making subdivisions and increasing the precision of classification; thus, the survey legend includes 5 orders, 11 suborders, and 18 great groups. A fourth level of classification, consisting of phases of great groups, is used to distinguish soil features that are significant to agricultural uses of soils. Examples are slope, soil depth, and susceptibility to flooding. The legend utilizes 35 phases of great groups.

TABLE 9.--Estimated soil properties affecting land use

| Map symbol and soil resource unit | Soil depth | Slope | Drainage | Soil texture and reaction | | Permeability | Available water capacity | Sodium content | Shrink-swell potential | Fertility level for rainfed crops |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Surface layer | Subsurface layer | | | | | |
| 1. Lake Chad shore deposits: | | | | | | | | | | |
| Natraqualfs, flooded | Moderately deep | Gently sloping | Somewhat poorly drained. | Moderately coarse; neutral. | Moderately fine; very strongly alkaline. | Very slow | Low | High | Low | Low. |
| Tropaquepts, flooded | Deep | Gently sloping | Somewhat poorly drained. | Coarse; neutral | Medium; mildly alkaline. | Moderate | Moderate | Low | Low | Medium. |
| 2. Sodic crests and wet depressions: | | | | | | | | | | |
| Natraqualfs, flooded | Moderately deep | Gently sloping | Somewhat poorly drained. | Moderately coarse; neutral. | Moderately fine; very strongly alkaline. | Very slow | Low | High | Low | Very low. |
| Pellusterts, flooded | Very deep | Level | Poorly drained | Fine; slightly acid. | Fine; neutral | Very slow | High | Low | High | Very high. |
| 3. Wet soils in broad depressions: | | | | | | | | | | |
| Tropaqualfs, flooded | Very deep | Level | Very poorly drained. | Fine; slightly acid. | Fine; neutral | Very slow | High | Low | High | High. |
| 4. River levee deposits: | | | | | | | | | | |
| Fluvaquents | Very deep | Gently sloping | Somewhat poorly drained. | Moderately coarse; slightly acid. | Medium; neutral | Moderate | Moderate | Low | Low | Medium. |
| Fluvaquents, flooded | Deep | Level | Very poorly drained. | Medium; medium acid. | Medium; medium acid. | Slow | High | Low | Low | Medium. |
| 5. Vertic alluvial plains: | | | | | | | | | | |
| Pellusterts, flooded | Very deep | Level | Poorly drained | Fine; slightly acid. | Fine; neutral | Very slow | High | Low | High | Very high. |
| 6. Floodways and alluvial fans: | | | | | | | | | | |
| Pellusterts, flooded | Very deep | Level | Poorly drained | Fine; slightly acid. | Fine; neutral | Very slow | High | Low | High | Very high. |
| Fluvaquents, flooded | Deep | Level | Very poorly drained. | Moderately coarse; Medium acid. | Medium; medium acid. | Slow | High | Low | Low | Medium. |
| 7. Sodic soils: | | | | | | | | | | |
| Natraqualfs | Moderately deep | Gently sloping | Moderately well drained. | Moderately coarse; neutral. | Fine; very strongly alkaline. | Very slow | Low | High | Low | Low. |
| Tropaquents | Very deep | Level | Poorly drained | Medium; neutral | Medium; strongly alkaline. | Moderate | High | ---------- | Low | High. |

TABLE 9.--Estimated soil properties affecting land use--Continued

| Map symbol and soil resource unit | Soil depth | Slope | Drainage | Soil texture and reaction | | Permeability | Available water capacity | Sodium content | Shrink-swell potential | Fertility level for rainfed crops |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Surface layer | Subsurface layer | | | | | |
| 8. Eroded sodic and vertic soils: | | | | | | | | | | |
| Natraqualfs, eroded | Moderately deep | Gently sloping | Moderately well drained. | Fine; mildly alkaline. | Fine; very strongly alkaline. | Very slow | Low | High | Low | Low. |
| Pellusterts, eroded | Moderately deep | Gently and moderately sloping. | Well drained | Fine; moderately alkaline. | Fine; moderately alkaline. | Very slow | Moderate | Low | High | Medium. |
| 9. Loamy soils overlying ironstone layers: | | | | | | | | | | |
| Haplustalfs, moderately deep | Moderately deep | Gently undulating | Well drained | Moderately coarse; slightly acid. | Fine; very strongly acid. | Slow | Moderate | Low | Moderate | Medium. |
| Tropaqualfs, depressed | Moderately deep | Level | Somewhat poorly drained. | Medium; slightly acid. | Fine; strongly acid. | Very slow | Moderate | Low | Moderate | Medium. |
| 10. Low sandy eolian terraces: | | | | | | | | | | |
| Ustropepts | Deep | Gently sloping | Somewhat excessively drained. | Coarse; medium acid. | Coarse; neutral | Rapid | Low | | Low | Medium. |
| Tropaquents | Very deep | Level | Poorly drained | Medium; neutral | Medium; strongly alkaline. | Moderate | High | | Low | High. |
| 11. Dunes and depressions: | | | | | | | | | | |
| Ustropepts | Deep | Gently sloping | Somewhat excessively drained. | Coarse; medium acid. | Coarse; neutral | Rapid | Low | | Low | Medium. |
| Tropaquents, flooded | Deep | Level | Very poorly drained. | Medium; medium acid. | Medium; medium acid. | Slow | Moderate | | Low | Medium. |
| 12. Undulating vertic uplands: | | | | | | | | | | |
| Chromusterts | Moderately deep | Gently sloping | Moderately well drained. | Fine; mildly alkaline. | Fine; moderately alkaline. | Slow | Moderate | Low | High | Very high. |
| Pellusterts | Deep | Level | Poorly drained | Fine; neutral | Fine; strongly alkaline. | Very slow | High | Low | High | High. |
| 13. Level vertic lowlands: | | | | | | | | | | |
| Pellusterts | Deep | Level | Poorly drained | Fine; slightly acid. | Fine; moderately alkaline. | Very slow | High | Low | High | High. |
| Chromusterts | Moderately deep | Gently sloping | Moderately well drained. | Fine; mildly alkaline. | Fine; moderately alkaline. | Slow | Moderate | Low | High | Very high. |
| 14. Foot slopes and outwash deposits: | | | | | | | | | | |
| Ustifluvents | Very deep | Gently sloping | Somewhat excessively drained. | Moderately coarse; medium acid. | Moderately coarse; slightly acid. | Rapid | Moderate | | Low | Medium. |
| Ustipsamments | Very deep | Moderately sloping. | Excessively drained. | Coarse; slightly acid. | Coarse, gravelly; neutral. | Rapid | Low | | Low | Medium. |

TABLE 9.--Estimated soil properties affecting land use--Continued

| Map symbol and soil resource unit | Soil depth | Slope | Drainage | Soil texture and reaction | | Permeability | Available water capacity | Sodium content | Shrink-swell potential | Fertility level for rainfed crops |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Surface layer | Subsurface layer | | | | | |
| 15. Shallow plateau soils and steep mountain slopes: | | | | | | | | | | |
| Ustorthents, shallow, gently sloping | Shallow | Gently sloping | Moderately well drained. | Moderately coarse; slightly acid. | Moderately coarse; strongly acid. | Rapid | Low | | Low | Medium. |
| Ustorthents, shallow, steep | Shallow | Steep | Excessively drained. | Coarse, stony; slightly acid. | Moderately coarse, stony; neutral. | Rapid | Low | | Low | Medium. |
| 16. Terraced mountain slopes: | | | | | | | | | | |
| Ustorthents shallow, terraced | Shallow | Steep | Excessively drained. | Coarse, stony; slightly acid. | Moderately coarse, stony; neutral. | Rapid | Low | | Low | Medium. |
| Rockland | None to very shallow. | Very steep | Excessively drained. | Coarse, gravelly and stony; slightly acid. | Neutral | | Low | | Low. | |
| 17. Sandy soils on uplands: | | | | | | | | | | |
| Paleustalfs | Very deep | Gently sloping | Moderately well drained. | Coarse; neutral | Moderately fine; medium acid. | Moderate | High | | Low | Medium. |
| Haplustalfs, deep | Deep | Gently rolling | Well drained | Moderately coarse; neutral. | Moderately fine, gravelly; medium acid. | Moderate | Moderate | | Low | Medium. |
| 18. Sandy soils and rocky hills: | | | | | | | | | | |
| Paleustalfs | Very deep | Gently sloping | Moderately well drained. | Coarse; neutral | Moderately fine; medium acid. | Moderate | High | | Low | Medium. |
| Ustropepts, shallow | Shallow | Steep | Excessively drained. | Moderately coarse, stony; neutral. | Medium, stony; medium acid. | Rapid | Low | | Low | High. |
| 19. Sodic and vertic soils on lowlands: | | | | | | | | | | |
| Tropaquents | Very deep | Level | Poorly drained | Medium; neutral | Medium; strongly alkaline. | Moderate | High | | Low | High. |
| Pellusterts | Very deep | Level | Poorly drained | Fine; slightly acid. | Fine; moderately alkaline. | Very slow | High | High at a depth of 100 centimeters. | High | High. |
| Natraqualfs | Deep | Level | Poorly drained | Moderately coarse; neutral. | Fine; strongly alkaline. | Very slow | Moderate | High | Low | Low. |
| 20. River deposits: | | | | | | | | | | |
| Ustifluvents, flooded | Very deep | Level | Somewhat poorly drained. | Moderately coarse; neutral. | Stratified; moderately alkaline. | Moderate | Moderate | | Low | Medium. |
| Pellusterts, flooded | Very deep | Level | Very poorly drained. | Fine; slightly acid. | Fine; neutral | Very slow | High | Low to moderate. | High | Very high. |
| 21. Claypan soils on lowlands: | | | | | | | | | | |
| Tropaqualfs, gently sloping | Deep | Gently sloping | Somewhat poorly drained. | Medium; moderately alkaline. | Fine; neutral | Very slow | Moderate | | Moderate | High. |
| 22. Shallow upland soils: | | | | | | | | | | |
| Haplustalfs, shallow | Shallow | Gently sloping | Well drained | Medium, gravelly; mildly alkaline. | Fine; mildly alkaline. | Slow | Low | | Low | Medium. |

TABLE 9.--Estimated soil properties affecting land use--Continued

| Map symbol and soil resource unit | Soil depth | Slope | Drainage | Soil texture and reaction | | Permeability | Available water capacity | Sodium content | Shrink-swell potential | Fertility level for rainfed crops |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Surface layer | Subsurface layer | | | | | |
| 23. Hill and valley complex: | | | | | | | | | | |
| Haplustalfs, deep | Deep | Gently sloping to rolling. | Well drained | Moderately coarse; neutral. | Moderately fine; medium acid. | Moderate | Moderate | | Low | Medium. |
| Tropaquepts | Deep | Gently sloping | Somewhat poorly drained. | Moderately coarse; neutral. | Medium; neutral | Slow | Moderate | | Low | Medium. |
| 24. Very deep sandy uplands: | | | | | | | | | | |
| Plinthustalfs | Very deep | Gently sloping | Moderately well drained. | Moderately coarse, gravelly; neutral. | Moderately fine, gravelly; medium acid. | Slow | High | | Low | Medium. |
| 25. Gravelly soils on sloping uplands: | | | | | | | | | | |
| Ustropepts, shallow | Shallow | Steep | Excessively drained. | Moderately coarse, stony; neutral. | Moderately fine, stony; medium acid. | Moderate | Low | | Low | Medium. |
| Ustorthents, moderately deep | Moderately deep | Moderately steep | Excessively drained. | Moderately coarse, gravelly; neutral. | Medium, gravelly; mildly alkaline. | Rapid | Moderate | | Low | Medium. |
| 26. Steep mountain slopes: | | | | | | | | | | |
| Ustorthents, shallow, steep | Shallow | Steep | Excessively drained. | Coarse, stony; slightly acid. | Moderately coarse, stony; medium acid. | Rapid | Low | | Low | Medium. |
| Rockland | None to very shallow. | Very steep | Excessively drained. | Coarse, gravelly, stony; slightly acid. | Neutral | | Low | | Low. | |
| 27. Stony steep plateau borders: | | | | | | | | | | |
| Dystropepts | Moderately deep | Strongly sloping | Excessively drained. | Medium, stony; strongly acid. | Moderately fine, stony; slightly acid. | Moderate | Moderate | | Low | Medium. |
| Ustorthents, shallow, steep | Shallow | Steep | Excessively drained. | Moderately coarse, stony; slightly acid. | Moderately coarse, stony; neutral. | Rapid | Low | | Low | Medium. |
| 28. Plateau upper slopes: | | | | | | | | | | |
| Paleustults | Very deep | Undulating | Well drained | Medium; very strongly acid. | Fine; strongly acid. | Slow | High | | Low | Low. |
| Haplustults | Deep | Gently sloping | Well drained | Medium; very strongly acid. | Fine; medium acid. | Slow | High | | Low | Medium. |
| 29. Plateau summits: | | | | | | | | | | |
| Tropohumults | Very deep | Gently sloping | Well drained | Medium; very strongly acid. | Moderately fine; medium acid. | Slow | High | | Low | Medium. |

Following is a key to the classification of taxonomic units in the survey area. The key is not intended to define fully any taxonomic class. It simply lists important morphological features that distinguish one soil from another. Other soil features that aid in identification are included in some definitions. No soil resource units are listed under Tropaquepts or Haplustults because they are not the most extensive components of any unit. Rockland consists of non-soil areas of exposed rock and areas of very shallow soils that are mainly Inceptisols or Entisols.

ALFISOLS.--Soils that are medium to high in bases and that have an accumulation of clay in the subsurface layer.
- Aqualfs: Alfisols that are continuously saturated in some or all layers for several months; soils that are gray or have mottles or iron and manganese concretions.
  - Natraqualfs--Alfisols that have a very strongly alkaline subsurface layer. Natraqualfs mapped in the survey area include soils in--
    - Soil resource unit 7--Natraqualfs with Tropaquents.
    - Soil resource unit 8--Natraqualfs, eroded; with Pellusterts, eroded.
    - Soil resource unit 2--Natraqualfs, flooded; with Pellusterts, flooded.
    - Soil resource unit 1--Natraqualfs, flooded; with Tropaquepts, flooded.
  - Tropaqualfs--Alfisols that have mean summer and winter soil temperatures that differ by less than 5° C.
    - Soil resource unit 21--Tropaqualfs, gently sloping.
    - Soil resource unit 3--Tropaqualfs, flooded.
- Ustalfs: Alfisols that are dry in some or all layers for long periods at the end of the rainfall season.
  - Plinthustalfs--Ustalfs that are mostly plinthite in lower layers; very deep soils with a loamy subsurface layer.
    - Soil resource unit 24--Plinthustalfs.
  - Paleustalfs--Ustalfs that have a thick clayey subsurface layer; very deep soils that have a reddish subsurface layer.
    - Soil resource unit 17--Paleustalfs with Haplustalfs, deep.
    - Soil resource unit 18--Paleustalfs with Ustropepts, shallow.
  - Haplustalfs--Ustalfs that are deep to shallow and have a thin loamy or clayey subsurface layer.
    - Soil resource unit 22--Haplustalfs, shallow.
    - Soil resource unit 9--Haplustalfs, moderately deep; with Tropaqualfs, depressed.
    - Soil resource unit 23--Haplustalfs, deep; with Tropaquepts.

ENTISOLS.--Soils that have little or no evidence of development of pedogenic layers.
- Aquents: Entisols that are wet for long periods, are gray, and have mottles.
  - Fluvaquents--Aquents with organic-matter content that decreases irregularly with depth.
    - Soil resource unit 4--Fluvaquents with Fluvaquents, flooded.

Tropaquents--Aquents that have mean summer and winter soil temperatures that differ by less than 5° C.

Soil resource unit 19--Tropaquents with Pellusterts and Natraqualfs.

Fluvents: Entisols that have stratified layers and unconsolidated deposits.

Ustifluvents--Fluvents that are dry in some or all layers for long periods at the end of the rainfall season.

Soil resource unit 14--Ustifluvents with Ustipsamments.

Soil resource unit 20--Ustifluvents, flooded; with Pellusterts, flooded.

Psamments: Entisols that have thick sandy subsurface layers.

Ustipsamments--Psamments that are dry in some or all layers for long periods at the end of one season of rainfall.

Orthents: Entisols that lack a thick sandy layer, are not stratified, and have unconsolidated deposits.

Ustorthents--Orthents that are dry in some or all layers for long periods at the end of one season of rainfall.

Soil resource unit 15--Ustorthents, shallow, gently sloping; with Ustorthents, shallow, steep.

Soil resource unit 26--Ustorthents, shallow, steep; with Rockland.

Soil resource unit 16--Ustorthents, shallow, terrace; with Rockland.

INCEPTISOLS.--Soils that have weakly differentiated layers.

Aquepts: Inceptisols that are saturated in all layers for brief periods and in lower layers for long periods, and that have mottles and are gray.

Tropaquepts--Aquepts that have mean summer and winter soil temperatures that differ by less than 5° C.

Tropepts: Inceptisols that have mean summer and winter soil temperatures that differ by less than 5° C.

Ustropepts--Tropepts that are dry in some or all layers for long periods at the end of the rainfall season, and that have base saturation of 50 percent or more in the subsurface layer.

Soil resource unit 10--Ustropepts with Tropaquents.

Soil resource unit 11--Ustropepts with Tropaquents, flooded.

Soil resource unit 25--Ustropepts, shallow; with Ustorthents, moderately deep.

Dystropepts--Tropepts that are sloping and have moderately low base saturation.

Soil resource unit 27--Dystropepts with Ustorthents, shallow, steep.

ULTISOLS.--Soils that are low in bases and have a subsurface layer of clay accumulation.

Humults: Ultisols that have a high organic-matter content; soils that continuously have subsurface moisture except for short dry seasons.

Tropohumults--Humults in which the subsurface layer has appreciable quantities of weatherable minerals and mean summer and winter soil temperatures that differ by less than 5° C; soils derived from basaltic parent material on plateau summits that have an elevation of more than 1,000 meters.

Soil resource unit 29--Tropohumults.

Ustults: Ultisols that have a low organic-matter content and are continuously dry for long periods.

Paleustults--Ustults that have a thick clayey subsurface layer without appreciable content of weatherable minerals; very deep soils with a reddish subsurface layer.

Soil resource unit 28--Paleustults with Haplustults.

Haplustults--Ustults that are deep with a yellowish clayey subsurface layer.

VERTISOLS.--Clayey soils that have wide deep cracks when dry.

Usterts: Vertisols that lose soil moisture gradually during a long dry season.

Chromusterts--Usterts that have a grayish brown surface layer.

Soil resource unit 12--Chromusterts with Pellusterts.

Pellusterts--Usterts that have a dark gray surface layer.

Soil resource unit 13--Pellusterts with Chromusterts.

Soil resource unit 5--Pellusterts, flooded.

Soil resource unit 6--Pellusterts, flooded; with Fluvaquents, flooded.

## Natural Plant Communities

A natural plant community, or range site, is a potential association of plants that is unique to a particular site under proper management.

The present plant community may differ greatly from the potential natural plant community because of past management practices. With proper use and management of the site, the potential plant community can be reestablished over a period of time.

Other terms often used to indicate a natural plant community are climax vegetation, potential native plant community, and potential plant community.

The same natural plant community can occur on more than one range site. In this survey area, however, the natural plant community in each of the 16 range sites is unique. Table 10 lists the species that make up the present and potential plant communities in each range site.

The map at the back of this survey shows the location of the natural plant community groups or range site groups in the survey area. These groups were determined by using the soil resource unit map (soil groupings) and field observations. Note that 3 of the natural plant communities are each shown in combination with another natural plant community.

## Water Resources

Three major aspects of water resources--rainfall, surface water, and ground water--are discussed separately in this section. Also discussed are irrigation, drainage, and water quality.

Apart from losses due to evaporation and plant transpiration, water from rainfall either becomes runoff, which flows into drainage basins in the survey area or is absorbed into the soil as ground water. A large volume of water affects that part of the survey area on the Chad Basin Lowlands. The water occurs as overbank flooding on broad alluvial plains in the Logone-Chari River system, which annually carries about 45 billion cubic meters of runoff from wet tropical highlands in Central Africa into the Lake Chad reservoir.

A list of significant documents that concern this project follows. See page iv for abbeviations of organizations.

1. Survey of water resources of the Chad Basin for development purposes. By LCBC. Specific documents. UNDF/FAO, Yaounde.
2. Detailed hydro-geological study in Northern Cameroon. By LERICI. Maps at scales of 1:200,000 and 1:500,000. FED, Yaounde.
3. General hydro-geological map of Garoua. By ORSTOM. Scale of 1:500,000. IRCAM, Yaounde.
4. Detailed hydro-geological map of Maroua-Fort Foureau. Scale of 1:500,000. GURC, Direction des Mines et de la Geologie, Yaounde.
5. Detailed hydro-geological study in the Benoue Valley. By WAKUTI. Report and maps. FED, Yaounde.
6. Detailed hydro-geological study in the Mandara region. By BRGM. Map segments at scale of 1:500,000. FED, Yaounde.
7. Hydrologie des mayos du Nord-Cameroun:Monographie de la Tsanaga. By ORSTOM. IRCAM, Yaounde.

TABLE 10.--Natural plant community and estimated yields

| Plant community | Range site No. | Range site Name | Resource area | Resource unit | Soils | Species that characterize plant community and estimated yield: Present composition | Estimated yield (Kilograms per hectare) | Present composition | Estimated yield (Kilograms per hectare) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-A | Sandy open savannah. | A, B, C | 8, 4 | Deep sandy loam soils that have layers of loam throughout the profile. | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Ctenium species<br>Aristida species<br>Eragrostis tremula<br>Acacia species<br>Combretum glutinosa<br>Annual grasses | 500-1,000 | Andropogon gayanus<br>Pennisetum species<br>Ctenium species<br>Acacia species | 1,000-2,000 |
| | 1-B | Sodic-------- | A, C | 7, 1, 2 | Strongly alkaline, eroded clayey soils; nearly level, localized areas. | Acacia species<br>Annual grasses | 100-500 | Acacia species<br>Hyperrhenia rufa<br>Aristida species<br>Annual seteria species<br>Eragrostis robusta | 500-1,000 |
| 2 | 2 | Flood plain-- | B | 3 | Nearly level, clayey soils; flooded 4 to 5 months annually. | Hyperrhenia rufa<br>Sporobolus pyramidalis<br>Seteria palidifusca<br>Rottobellia exaltata<br>Annual sorghums | 6,000-8,000 | Oryza barthii<br>Hyperrhenia rufa<br>Echinochloa pyramidalis<br>Sporobolus pyramidalis<br>Perennials | 8,000-10,000 |
| 3 | 3-A | Stony loamy savannah. | C, F, G | 22, 9, 18 | Soils that have a stony, loamy surface layer; deep to shallow, sloping. | Hyperrhenia rufa<br>Eragrostis species<br>Aristida species<br>Acacia senegal<br>Balanites aegyptica | 2,000-3,000 | Hyperrhenia rufa<br>Andropogon gayanus<br>Pennisetum species<br>Acacia senegal<br>Balanites aegyptica | 2,500-4,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 3-B | Red ferruginous savannah. | F, G | 23 | Deep red, sandy loam soils; gently sloping, iron cemented pan. | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Andropogon gayanus<br>Cymbopogon proximus<br>Ctenium canesiens<br>Aristida species<br>Acacia species<br>Ficus species<br>Commiphora africana<br>Seleracarya bierre | 2,000-3,500 | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Andropogon gayanus<br>Ctenium canesiens<br>Acacia species<br>Ficus species<br>Commiphora africana<br>Seleracarya bierre | 2,500-4,000 |
| 4 | 4 | Deep loamy savannah. | E, G | 24, 17 | Soils that have a deep to moderately deep loamy surface layer; gently sloping. | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Andropogon gayanus<br>Cymbopogon proximus<br>Ctenium canesiens<br>Artistida species<br>Acacia species<br>Ficus species<br>Commiphora africana<br>Seleracarya bierre | 3,000-5,000 | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Andropogon gayanus<br>Ctenium canesiens<br>Acacia species<br>Ficus species<br>Commiphora africana<br>Seleracarya bierre | 3,500-6,000 |
| 5 | 5 | Meadows------- | E | 19 | Wet lowland soils---- | Hyperrhenia rufa<br>Annual grasses<br>Cyperus species<br>Panicum species | 5,000-7,000 | Andropogon gayanus<br>Echinochloa pyramidalis<br>Sporobolus pyramidalis<br>Hyperrhenia rufa<br>Panicum species<br>Cyperus species | 6,000-8,000 |
| 6 | 6 | River bottom-- | E | 20 | Alluvial flood plain, river deposits; floods 4 to 5 months annually. | Hyperrhenia rufa<br>Annual grasses<br>Cyperus species<br>Schizachyrium brevifolium<br>Panicum species<br>Seteria species<br>Mimosa species | 5,000-7,000 | Andropogon gayanus<br>Hyperrhenia rufa<br>Echinochloa pyramidalis<br>Panicum species<br>Mimosa species | 6,000-8,000 |

TABLE 10.--Natural plant community and estimated yields--Continued

| Plant community | Range site No. | Range site Name | Resource area | Resource unit | Soils | Species that characterize plant community and estimated yield: Present composition | Estimated yield (Kilograms per hectare) | Present composition | Estimated yield (Kilograms per hectare) |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 7 | Alluvial granitic savannah. | D | 14 | Colluvial foot slopes and outwash plains; soils of granitic origin. | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Eragrostis robusta<br>Annual grasses<br>Ficus species<br>Balanites aegyptica<br>Acacia albida<br>Acacia seyel<br>Acacia senegal<br>Acacia tortilis<br>Combretum glutinosum | 600-1,200 | Hyperrhenia rufa<br>Heteropogon centartus<br>Andropogon gayanus<br>Aristida species<br>Ficus species<br>Balanites aegyptica<br>Acacia species | 1,000-2,000 |
| 8 | 8-A | Shallow rocky slopes. | D | 16 | Shallow, gravelly loamy soils on rocky slopes. | Loudetia togoensis<br>Eragrostis tremula<br>Aristida species<br>Ficus species<br>Balanites aegyptica<br>Acacia species | 600-1,200 | Hyperrhenia rufa<br>Heteropogon contartus<br>Andropogon gayanus<br>Aristida species<br>Ficus species<br>Balanites aegyptica<br>Acacia species | 1,000-2,000 |
| | 8-B | Upland plateau. | D | 15 | Shallow to moderately deep, gravelly loamy; gently sloping. | Hyperrhenia rufa<br>Seteria palidifusca | 1,500-2,500 | Hyperrhenia rufa<br>Andropogon gayanus<br>Aristida species<br>Pennisetum pedicellatum | 2,500-4,000 |
| 9 | 9 | Steep mountain savannah. | H, I | 26, 27 | Steep slopes, soils that have a coarse loamy surface layer and a fine loamy subsurface layer; frequent rocks and ironstone outcroppings. | Hyperrhenia rufa<br>Imperata species<br>Pennisetum species<br>Panicum species<br>Andropogon species<br>Eragrostis species<br>Anona arenara<br>Crossopteryx species | 3,000-5,000 | Hyperhenia rufa<br>Imperata species<br>Pennisetum species<br>Panicum species<br>Andropogon species<br>Eragrostis species<br>Anona arenara<br>Crossopteryx species | 3,000-5,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10 | 10 | Sandy dense savannah. | C, F | 10, 11, 25 | Deep sands that are gently undulating on wind-formed terraces; gravelly sandy loams on sloping uplands. | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Andropogon gayanus<br>Cymbopogon proximus<br>Ctenium canesiens<br>Aristida species<br>Acacia species<br>Ficus species<br>Commiphora africana<br>Seleracarya bierre | 3,000-5,000 | Hyperrhenia rufa<br>Pennisetum pedicellatum<br>Andropogon gayanus<br>Ctenium canesiens<br>Acacia species<br>Ficus species<br>Commiphora africana<br>Seleracarya bierre | 3,500-5,000 |
| 11 | 11 | High plateau-- | I | 28, 29 | Deep soils that have a reddish fine loam surface layer and a fine silty subsurface layer; gently sloping. | Panicum phargmitods<br>Andropogon gayanus<br>Hyperrhenia rufa<br>Seteria species<br>Pennisetum species<br>Sporobolus species<br>Bridelia species<br>Cussonia barteri<br>Ficus thonnigii | 2,000-5,000 | Andropogon gayanus<br>Panicum species<br>Hyperrhenia rufa<br>Pennisetum species<br>Imperata cylindrica<br>Schizachyrium brevifolium<br>Cussonia barteri<br>Ficus thonnigii | 4,000-6,000 |
| 1 and 12 | 12 | Clayey savannah. | A, B, C, F | 12, 13, 5, 6 | Clayey soils on alluvial flood plain that develop deep, wide cracks when dry; moderately level. | Aristida species<br>Hyperrhenia rufa<br>Annual seterias<br>Other annual grasses<br>Acacia species<br>Combretum glutinosa | 800-1,500 | Andropogon gayanus<br>Hyperrhenia rufa<br>Seteria palidifusca<br>Seteria communis<br>Acacia species | 1,800-3,000 |
| 13 | 13 | Clay hardpan savannah. | F | 21 | Nearly level clayey soils on lowlands. | Anogeissus leiocarpus<br>Terminalia species<br>Acacia siberiana<br>Butyrospermum parkii<br>Combretum species | 1,000-2,000 | Hyperrhenia rufa<br>Andropogon gayanus<br>Anogeissus leiocarpus<br>Terminalia siberiana<br>Butyrospermum parkii | 1,500-3,000 |

## Rainfall

The average annual rainfall within the survey area varies from about 500 millimeters in the northern part to 1,500 millimeters in the southern part.

Rainfall, considered as a resource element, can only be evaluated within the framework of complex hydrological and geological relationships. In Cameroon, the Ministry of Mines and Energy has begun an active program of hydrological investigation that incorporates the efforts of a number of contract groups. The raw climatological data is filed at the Meteorological Service, Ministry of Mines and Energy, in Douala.

Many stations in the survey area currently record meteorological data. Comprehensive predictions can be made from the data collected at about 6 stations.

The amount of rainfall decreases with distance from the southern limits of the survey area, in the vicinity of Ngaoundere, northward toward Lake Chad. Isolated mountains in the South Benoue area and the Mandara Highlands reflect a localized increase in rainfall in proportion to increases in elevation. Such terrain is typically modified by "rain-shadow" effects, but there is not enough evidence in the form of extensive point reports to adequately measure these effects. The decrease in the amount of annual rainfall with distance northward is illustrated as follows: Ngaoundere receives 1,574 millimeters annually; Garoua, 982 millimeters; Maroua, 804 millimeters; and Lake Chad shore, 500 millimeters.

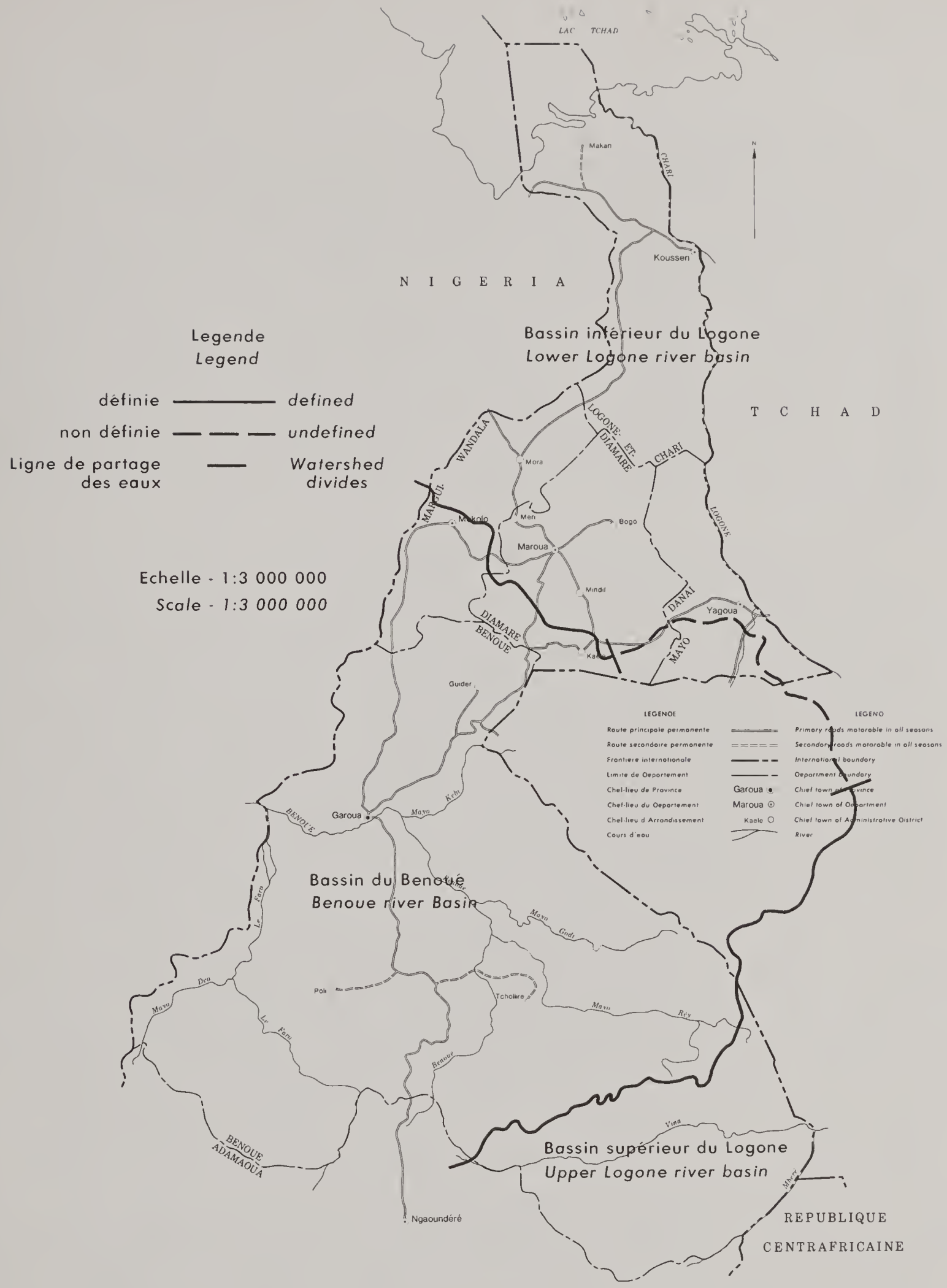
The effects of decreasing annual rainfall with increasing distance northward combine with the effects of seasonal variations in the time of occurence of rainfall to decrease agricultural production. This combination of variables needs to be considered in agricultural planning. The lowered crop yields in the period 1971 to 1973, for example, were caused mainly by insufficient rainfall at critical times for crop growth, rather than by a condition of general drought.

Annual rainfall minimums have been established for these crops: cotton, 700 to 800 millimeters; sorghum, 500 millimeters; and millet, 250 millimeters.

## Surface water

The survey area has two principal river systems, the Benoue and the Logone (fig. 5). An important water resource originates in uplands outside the survey area and causes seasonal flooding of the alluvial lowlands associated with the Logone-Chari River system.

The Benoue River in North Cameroon makes up the upper sector of a major drainage basin of the Niger River network. It flows permanently almost 800 kilometers to the southwest. In Cameroon, its channel is 350 kilometers long. About 25 percent of the total watershed that discharges water beyond the Cameroon frontier lies in Chad. The section that is in Cameroon is marked by distinct radiating branch streams that are steep enough in the upper reaches so that velocity is rapid. The flow rate varies greatly and erosion is severe in highland areas. As a result, large volumes of rock debris and earth deposits typically impede the channel discharge of tributaries. This causes flooding and deposition of sand on fertile soils on the valley foot slopes. Major channels are the main stem of the Benoue River, the Faro River and its Mayo-Deo tributary, and the channels of the Mayo-Godi, Mayo-Louti, and Mayo-Kebi. The watershed of the Mayo-Kebi is mainly in Chad.




Echelle - 1:3 000 000

*Scale - 1:3 000 000*

Figure 5 - Bassins des rivières

*River basins*

The irregular flow rate of the Benoue River limits its potential as a source of supplemental irrigation. The fertility of the soils in the broad alluvial basins is high, but flooding and prolonged wetness limit their use. The Benoue River is navigable to barge traffic downstream from Garoua.

The Logone River flows 900 kilometers from its headwaters to its confluence with the Chari River which then flows another 100 kilometers into Lake Chad. The Logone River, for a distance of 300 kilometers upstream from this confluence, forms the frontier between Chad and Cameroon. This river system in North Cameroon is made up of three separate elements: (1) the upper Logone Occidental, the segments of which are the Vina du Nord and the Mbere Rivers; (2) the subwatersheds parallel to the Diamare Plains; and (3) the alluvial flood plain of the lower Logone River and the Logone-Chari delta. The Logone River system in North Cameroon contrasts geographically with that of the Benoue, but the steepness of its tributary subwatersheds are similar.

Watershed characteristics of the upper Logone Occidental are similar to those of tributary sections of the Benoue system. These characteristics include irregular flow rates and severe hazards of erosion and sedimentation.

The Diamare Plains consist mainly of numerous small, elongated, subwatersheds that are parallel to the broad alluvial plain of the Logone. These subwatersheds discharge runoff water and deposit sediment in a network of outwash splays. These splays range to about 2,000 square kilometers in size and include subwatersheds of the Mayo-Ngassa, Mayo-Boula, and Mayo-Tsanaga. Mayo-Tsanaga has the following hydro-geological features, which are typical of the other subwatersheds: (1) an intermittent flood flow that has a wide range in amplitude; (2) disappearance of channel characteristics in downstream areas; and (3) deposition of large volumes of sediment in the vast flood plain. Continuous channel flow occurs in July, and flash flooding occurs in August and September. Between October and May, surface discharge gradually diminishes and then disappears, forming useful shallow-water areas.

The lower section of the Logone River consists of a broad, level plain that was once part of the bottom of Lake Chad. A slight increase in the rate of channel flow causes overflowing of the channel, first in the vicinity of Yagoua and then in breaches downstream. This allows water to spread over the broad alluvial plain behind natural levees. Widespread flooding results, and a large volume of water is exposed to evaporation. With excessive rise of water from headwater sources, water is diverted by natural spillage across the low saddle into the Benoue River system by way of the Mayo-Kebi. This annual loss of water from the Logone supply is estimated at 40 million cubic meters.

The channel flow of the Logone in the vicinity of Yagoua forms the basis for an important irrigated rice production. The low discharge stage, which occurs in March and April, provides a reliable supply of dry-season water for irrigation downstream. Flooding of the alluvial plain is commonly to a height of 80 to 120 millimeters for a period of 3 to 6 months in broad reaches and continuously in enclosed depressions; this provides water for a significant fishing industry and insures a necessary source of food for a sizeable population.

The water discharge volumes at several locations in the survey area are given below.

Water discharge at selected cross-sections
(cubic millimeters per second)

| River | Station | Low water stage | Flood stage |
|---|---|---|---|
| Benoue system: | | | |
| Benoue | Garoua | 1 | 2,375 |
| Logone system: | | | |
| Vina | Wakwa | 7 | 164 |
| Kalliao | Maroua | Underground | 228 |
| Tanaga | Bogo | Underground | 210 |
| Logone | Yagoua | 50 | 905 |
| Logone | Kousseri | 45 | 920 |

## Ground water

Hydro-geological investigations in Cameroon, and especially in North Cameroon, have been fragmental throughout both the colonial and independence periods. Studies have not been done at a large enough scale to permit regional planning. The main obstacles to a useful development program are the difficulty in drilling boreholes in substrata dominated by hard rock and the inability to finance exploratory study. The Ministry of Mines and Energy has implemented a comprehensive study of ground water resources in North Cameroon under the direction of UNDF, and preliminary data are available.

Investigations to date have resulted in the following generalizations:

1. Ground water resources are nonexistent or impractical to develop in areas of high relief where the unconsolidated earth mantle is relatively shallow over massive, crystalline rock substrata. These materials are weakly veined and stratified.
2. Potential is moderate for shallow ground water supplies in the area of Cretaceous sandstone outcrop in the lowest reaches of the Benoue basin and at an elevation of less than 250 meters.
3. The beveled erosional surfaces adjacent to and downslope from the Mandara Highlands--in the areas of Gidigis and Mindif and on the peneplain northeast of Mora--lack appreciable potential for ground water development.
4. The region identified as an ancient lakebed of Lake Chad, which is generally characterized by the "cordon" dune deposit that extends from Yagoua northwest to Limani, has increasing potential with distance northward to the present shores of Lake Chad. Areas with moderate potential for shallow wells include the Yagoua-Kalfou-Doukoula vicinity, Maroua-Bogo vicinity, and the vicinity near Djaoude.
5. Artesian ground water development is practical north of a line extending from Pouss to Waza, and strength of the discharge increases northward.
6. Springs are common and moderately productive in the northern escarpment border of the Adamaoua Plateau. Occasional meager spring flows occur in dissected areas of the Mandara Highlands, and some can be developed for seasonal use.

In general, hydrogeologists advise against the broad scale use of artesian ground water to avoid depletion of reserves that are a part of the delicate balance sustaining Lake Chad. Also, the perched water tables at certain depths is too saline for optimum irrigation use. Any plan for the use and management of deepwater sources in North Cameroon should take into account the extravagant use of ground water reservoirs in the Chad Lowlands in bordering Nigeria. Many wells are only a few kilometers outside the national frontier of Cameroon.

The use of ground water for small, local irrigation projects is feasible and economical in the Diamare Plains and northward where the surface of the water table is within 10 meters of ground level and where water can be raised by simple and inexpensive means, for example, by an animal-operated Persian wheel or by mechanical pumping. Potential for development of ground water supplies is highest in the Logone-Chari Delta area; the cost of developing this source, however, needs to be weighed against the cost of delivering Lake Chad water by canal. Figure 6 shows the depth to a useful phreatic water table in the Chad Basin Lowlands.

## Irrigation

The use of ground water for irrigation has been the subject of intensive study by the Lake Chad Basin Commission. The availability of irrigation water, either surface water or subterranean, can promote a wide range of agricultural uses in the Logone alluvial plains area, where the decreasing rainfall with distance northward inhibits agricultural development. With irrigation, the traditional, single-crop pattern (millet followed by grass fallow) now used can be expanded to a mixed-crop pattern including beans, groundnuts, and cotton. Moreover, in areas that have potential for irrigation and where soil conditions are favorable, maize and tuber crops can be grown.

Intensive study and regional water management is needed to increase rice production in the Grand Yaere region. Studies show that if the irrigation complex controlled by the Secteur Experimental de Modernization de la Riziculture de Yagoua (SEMRY) is extended into adjacent, downstream sites and the Logone River is not regulated, higher flood peaks in the Logone-Chari Delta area will result, posing a threat to local agriculture. A better approach is to extend irrigation development westward from the river into the broad depression of soil resource unit 3.

Potential is good for riparian irrigation on the flood plain soils north of Logone-Birni. Irrigation studies in the Kousseri vicinity show that soils irrigated by channel-delivered water would be suited to rice and wheat.

By 1990, irrigation development in the survey area can be completed on 28,000 hectares in the Logone Basin and on 32,000 hectares in the Benoue Basin. The development of sources in the Benoue Basin, however, depends on construction of the Lagdo Dam. Table 11 presents estimates of land presently irrigated and land to be irrigated by 1990. These estimates do not represent the total area of land that has potential for irrigation if an adequate water supply was available.

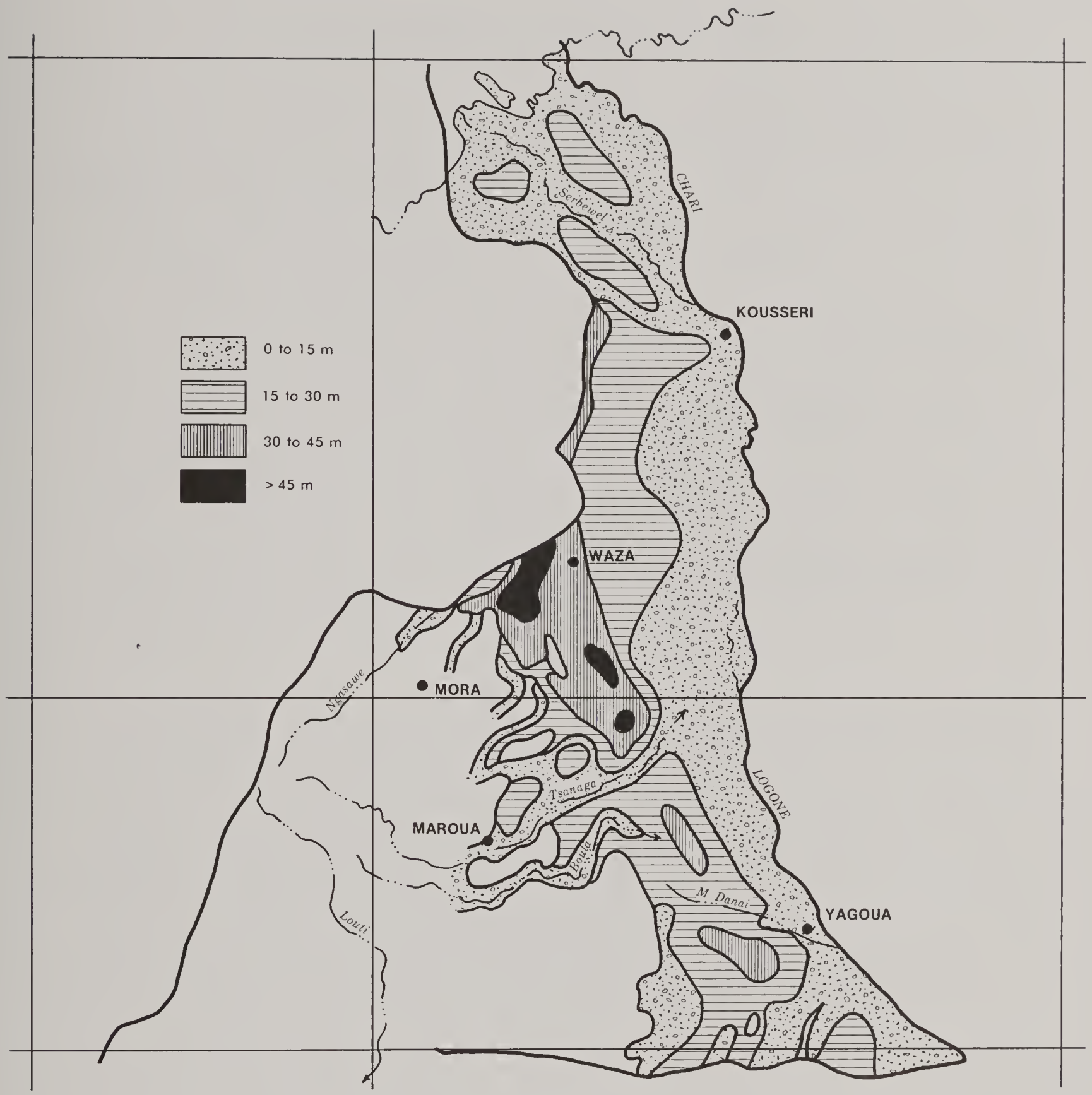



Figure 6 - Profondeur de la nappe phréatique dans la cuvette tchadienne

*Depth to the regional phreatic water table in the Chad basin lowlands*

TABLE 11.--Summary of irrigable land

| Area | Irrigated in 1975 | Feasible for irrigation development by 1990 |
|---|---|---|
| | Hectares | Hectares |
| Logone Basin: | | |
| Semry | 3,000 | ------ |
| River tributaries and Lake Chad shore area | 5,000 | ------ |
| South of Kousserie (Logone) | ----- | 8,000 |
| North of Kousserie (Chari, El Beid, and Serbeouil) | ----- | 12,000 |
| Total | 8,000 | 20,000 |
| Benoue Basin: | | |
| Lower Benoue | 220 | 1/ 30,000 |
| Upper Benoue | 150 | 1/ 1,500 |
| Total | 370 | 31,500 |

1/ Irrigation depends on completion of Lagdo Dam.

## Drainage

An estimated 9,800 square kilometers of land in the survey area, part of the Logone-Chari alluvial plain, is flooded every year by bank overspill and by runoff from precipitation. The flood season generally extends from mid-August to the end of January. Flood flow begins to subside in September, but water drains slowly because relief is flat. Large depressions become perennial marshes where shallow water is impounded or the surface remains saturated.

Most of the water flooding the Grand Yaere, a region of about 5,000 square kilometers, is lost by evaporation. Less than one-fourth of the water is delivered to the El Beid delta channel.

A number of interrelated factors are important in considering drainage measures designed to increase the productive capacity of the area. Benefits from such measures include: (1) Rice could be effectively grown where flooding is not excessive or where it can be controlled. (2) Management of receding surface water would allow cultivation of dry season sorghum in a non-rainfall period. (3) Differential flooding would provide a sort of enforced grazing management of grassland, thus reserving a valuable grazing resource for the dry season. (4) Seasonal flooding of the Grand Yaere would bring a sensitive balance to the fish breeding cycle, thus providing a valuable human food resource. Foremost among the detrimental effects are: (1) disruption of communications, (2) exclusion of large areas of land from permanent human habitation, and (3) loss of use of the land for 3 months or more.

## Water quality

No harmful concentrations of toxic elements, particularly selenium and boron, are found in surface waters in North Cameroon. Both surface and phreatic water supplies have low salt content and are well suited to irrigation. Locally, outcropping seepage waters, especially northwest of Kousseri, may be saline and sometimes sodic as a result of percolation through sodic soils in the vicinity. Artesian ground water varies in salinity. An occasional discharge exceeds 500 parts per million of total solids and has marginal potential for irrigation. Lake Chad waters vary somewhat from south to north; however, available water supplies have less than 200 parts per million of total solids and present no hazard to use.

## Planning the Use and Management of Resources

Agronomists, geographers, livestock specialists, soil scientists, and soil conservationists keep extensive notes, when making a resource inventory, about the nature of the resources and their behavior in the field. They record data on native plant communities, changes in vegetation because of the use, soil behavior under specific management, yield estimates, suitable crops and management systems, flooding, social behavior, and livestock management systems and marketing practices. Other data relate to the resources and their productivity, potentials, and limitations under various uses and management. Social and other constraints on the development of resources are also noted.

Information in this section will be useful in the application of basic facts about the resources to planning and development, use, and management of land resources for range and crops and for nonagricultural uses, for example, wildlife habitat. From the data presented, the potential of each resource subunit for specified land uses can be determined, limitations of the resources and social and other constraints to their use can be identified, and costly failures that result from land use that is not suited to the environment can be avoided.

Planners and others using the resource inventory can evaluate the impact of specific land uses on the overall development of the region and division and on the environment. Plants can be used to maintain or create a land use and development pattern in harmony with the natural environment.

Also included in the section are social and economic conditions and livestock management concerns that merit consideration in planning.

### Agronomy

In this section, the major management concerns for crop cultivation in North Cameroon are discussed. The crops best adapted to each soil resource unit, including some crops not commonly grown, are discussed; the system of determining the potential for crops is explained; predicted yields for major crops are given; and the estimated potential for the main crops is presented for each resource subunit.

#### The present situation

Although only about 5 percent of the survey area is cultivated, the local people are almost entirely dependent on the cropped area for food.

North Cameroon is largely self-sufficient in food production. Food production is increasing 3.0 to 3.5 percent annually, ahead of the annual population growth rate of 2.1 percent.

The 1972-73 drought resulted in food shortages in many parts of North Cameroon. In the growing season following the drought, subsistence farmers, uncertain of the adequacy of the food supply, made readjustments in the size of areas used for cash crops and grew more food crops instead. For example the area planted in cotton in 1971-72 exceeded 111,000 hectares, but in 1973-74 it was slightly more than 60,000 hectares.

## Areas under cultivation and crops planted

Available statistics regarding areas under cultivation and crop yields are moderately accurate. The agricultural study made in the Northern Province in 1973-74 supplies some information, but the amount of interplanting is probably less than the results of that study indicate. Traditional farming has remained constant since the early 1960's, although some adjustments have been made for varying conditions. Estimates of the areas under cultivation in 1974 are given in Table 12.

## Use of animals for farmwork

A study into the use of animals for farmwork in North Cameroon was made by M. Fournier in 1973, and published in his book, La Culture Attelee au Nord Cameroun. Figures from this study and figures representing the sale of animals and implements by the Societe de Développement du Coton (SODECOTON) and from agricultural services are given below.

| District | Teams | | Plows | | Carts | Ridging Implements |
|---|---|---|---|---|---|---|
| | Oxen | Asses | Oxen | Asses | | |
| Logone and Wandala: | | | | | | |
| 1973---------- | 23 | --- | 81 | --- | ----- | --- |
| 1974---------- | ----- | --- | ----- | --- | ----- | --- |
| Total---------- | 23 | --- | 81 | --- | ----- | --- |
| Margui-Wandala: | | | | | | |
| 1973---------- | 2,104 | 85 | 2,849 | 87 | 269 | 168 |
| 1974---------- | ----- | --- | 91 | 95 | 1 | --- |
| Total---------- | 2,104 | 85 | 2,940 | 182 | 270 | 168 |
| Mayo-Danai: | | | | | | |
| 1973---------- | 1,454 | 16 | 2,275 | 16 | 347 | 8 |
| 1974---------- | ----- | --- | ----- | --- | --- | --- |
| Total---------- | 1,454 | 16 | 2,275 | 16 | 347 | 8 |
| Diamare: | | | | | | |
| 1973---------- | 3,612 | 661 | 5,019 | 763 | 1,093 | 209 |
| 1974---------- | 222 | --- | 301 | 206 | 56 | --- |
| Total---------- | 3,834 | 661 | 5,320 | 969 | 1,149 | 209 |
| Benoue: | | | | | | |
| 1973---------- | 4,462 | 241 | 5,150 | 274 | 266 | 260 |
| 1974---------- | ----- | --- | 1,268 | 163 | 46 | --- |
| Total---------- | 4,462 | 241 | 6,418 | 437 | 312 | 260 |

The study by Fournier indicates that the amount of unused equipment may run as high as 40 percent of the total.

TABLE 12.--Estimated area planted to selected crops, 1974

| Resource area | Size of area | Area planted to crops | Area planted to-- | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sorghum | | Millet | Cotton | Peanuts 1/ | Rice | Corn | Others 1/ |
| | | | Wet season | Dry season | | | | | | |
| | Hectares | Hectares | Hectares | Hectares | Hectares | Hectares | Hectares | Hectares | Hectares | Hectares |
| A | 500,000 | 15,700 | 5,300 | 2,000 | 2,000 | ------ | ------ | 200 | 5,100 | 1,100 |
| B | 800,000 | 41,200 | 11,400 | 5,900 | 1,900 | 5,500 | 6,500 | 6,500 | 900 | 2,600 |
| C | 1,800,000 | 277,100 | 88,900 | 86,900 | 20,900 | 37,900 | 33,200 | 600 | 1,700 | 7,000 |
| D | 600,000 | 107,800 | 64,500 | ------- | 16,400 | 2,000 | 18,800 | ------ | 300 | 5,800 |
| E | 1,350,000 | 44,800 | 9,200 | 17,000 | 500 | 4,200 | 6,900 | 2,200 | 2,300 | 2,500 |
| F | 2,000,000 | 79,000 | 34,400 | ------- | 3,400 | 11,500 | 22,100 | 700 | 600 | 7,200 |
| G | 1,300,000 | 11,100 | 4,300 | ------- | 1,500 | 2,300 | 1,900 | ------ | 500 | 700 |
| H | 600,000 | 8,400 | 4,700 | ------- | 1,600 | 100 | 1,200 | ------ | 300 | 500 |
| I | 1,050,000 | 6,100 | 2,700 | ------- | ------ | 1,000 | 700 | ------ | 1,100 | 600 |
| Total | 10,000,000 | 2/ 591,200 | 225,400 | 111,800 | 48,200 | 64,500 | 91,200 | 10,200 | 12,800 | 28,000 |

1/ Often interplanted with sorghum, millet, and corn.

2/ Actual cultivated area is approximately 500,000 hectares; because of interplantings some hectares are counted more than once.

The Diamare and Benoue districts have the most farm animals. The use of asses is common in Diamare, because of the nature of the soil and the fact that asses are considerably cheaper than oxen. An ass can be bought for CFAF2,000 to 3,000. The use of asses is the most economical method of cultivation only in areas that have predominantly sandy soils. Ass plows are used on about 4,000 hectares.

There are about 17,000 ox plows in the five districts. Assuming use of 70 percent of the plows and an average area of 4 hectares worked by each plow, then nearly 48,000 hectares are plowed by oxen.

## Use of fertilizers

Use of fertilizers increased rapidly during the period 1965 to 1971. The fertilizer program initially provided substantial subsidies of 50 to 60 percent of the price. The subsidies declined to 20 percent by 1969 and disappeared after 1971. By that time, farmers were expected to be aware of the production increase resulting from the use of fertilizers and thus willing to pay for fertilizers.

After subsidies ended in 1971, fertilizer sales dropped sharply in 1972. Reasons for the decline in sales, however, appear to be more complex than just the elimination of subsidies. The withdrawal of the subsidies coincided with sharp increases in world fertilizer prices. The wholesale price for ammonium sulfate in North Cameroon increased from CFAF15,000 per ton in 1970 to CFAF22,000 per ton in 1973, and for 20-10-10 fertilizer from CFAF21,300 per ton in 1970 to CFAF31,200 per ton in 1973. The increase in the wholesale price of fertilizer was 27 percent, but the farmer who no longer received subsidies paid an increase of about 70 percent.

## Grasshoppers and bird pests

The control of bird and grasshopper pests is carried on by two international organizations: OCCLALAV, which operates in Chad and Cameroon against grain-eating birds, migratory locusts, and grasshoppers, and OICMA, which also works in both countries primarily to control African migratory locusts and grasshoppers.

## Institutional framework

The institutional support of food crop production is generally inadequate to increase and improve production of staple crops. Research is inadequate, management skills are lacking, and improved techniques are not effectively communicated to small farmers. Delivery systems for food crop production are virtually non-existent. In addition, the inability to properly store and move food crops into commercial circuits leads to a considerable loss of income to poor farmers.

## Labor supply

All crop production for subsistence and for commercial use is done by the family unit. About 90 percent of all cultivation is done by hand, and 10 percent is done by animals. The basic family unit varies, but generally it consists of one male, the head of the family, and his three wives who have two children each. On the average there are about 2.8 members 14 years of age or older capable of working in the field. A typical family work force can be broken down into man-days as follows:

| | | | |
|---|---|---|---|
| 1 male | = | 1.0 man-days | = 1.0 |
| 3 females | = | .6 man-days | = 1.8 |
| 2 children | = | .3 man-days | = 0.6 |
| Total | | | 3.4 |

The family is capable of working 85 man-days per month, assuming that there are 25 working days per month.

## Population growth and future food needs

The population in the year 2000, at the present rate of growth, is projected at 1.8 million persons. The annual requirement for basic cereals in the year 2000 at the present rate of consumption is estimated at 360,000 tons.

# Crops

Food grain and groundnuts for human consumption are the main crops and are grown on more than eighty percent of the cultivated area. Sorghum and millet are the main staple foods. These crops are grown throughout the area. Two types of crops are important: those grown during the wet season and those grown during the dry season. The primary dry-season crop is transplant sorghum. It is grown on soils that are too wet for sorghum during the rainy season. It depends almost entirely on stored soil moisture for growth.

## Sorghum and millet

Sorghum and millet are the main staple foods in North Cameroon. They are cultivated in an area that extends from the shores of Lake Chad to the Adamaoua Department. According to figures in table 12, 385,400 hectares were planted in sorghum and millet in 1974. The average yield was 700 kilos per hectare.

During the rainy season, a limited amount of penicillary millet is grown in the Mandara Mountains. It is alternated with sorghum. It is also grown on the sandy soils in the Yagoua region. There are several varieties of sorghum, and at least one is grown in all districts.

During the dry season, transplant sorghum is grown on very clayey soils in clearly defined geographical areas.

The following varieties of sorghum and millet are cultivated in North Cameroon:

Wet-season sorghum: Wet-season sorghum is grown in more than 60 percent of the area that is planted to sorghum. There are 5 principal varieties: Djigaris (including Damougaris and Makalaris types), Boulbassiris, Walaganaris, Tchergues, and Yolobris.

The principal characteristics of each type of wet-season sorghum are given in table 13. Those varieties whose grains do not have a brown layer yield a white flour that is much preferred by consumers. Grains that have a glassy appearance are much sought after by the Foulbe. The Yolobris is a late variety of sorghum. It is generally found in areas where annual rainfall is below 900 millimeters. The Tchergues is an early variety that has a large grain and is grown on the shallow soils of the mountainous regions near Mokolo and Meri. It is alternated with penicillary millet by farmers of this region. The Damougaris and Makalaris are late varieties of sorghum, or between-season sorghum, that are frequently cultivated in the Diamare district.

The Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres (IRAT) has made a selection from among the local varieties of sorghum. The attempt to introduce very early varieties in the southern part of North Cameroon failed because the humidity caused the inflorescense to rot. These varieties were very susceptible to a disease of the leaves, known as Cerospora. IRAT would like to find a variety that has a shorter stem to obtain a better stem grain which at present may grow more than 4 meters high. A high-yield variety, IRAT 55, has been developed, but this variety is not suitable for all regions, and it has red grains. It has, however, a maturation period of 60 to 80 days. The short-stemmed varieties are not always readily accepted by the local people, who use sorghum stems to make roofs and fences.

Penicillary varieties: These varieties are grown in about 10 percent of the area in millet and sorghum. There is no direct research being made on these varieties in Cameroon; however, a study is underway at Bambey in Senegal. The varieties tested there and approved will be introduced to Cameroon. IRAT has a collection of Senegalese varieties, one of which is Souna 2. It is likely that bearded varieties will be favored because they are less subject to attack by "mange-mils" (midge pests).

Transplant sorghum: About 40 percent of the total production of sorghum and millet in North Cameroon is transplant sorghum. Mouskouaris and Babouris are the two types of transplant sorghum. The differences between them are the length of the growth cycle and the kind of soil needed for growth. Mouskouaris is a dry-season sorghum. Table 14 shows the characteristics of the different Mouskouaris. These are very popular sorghums because the flour obtained from them is white. Mouskouaris are generally transplanted in October, after the rainy season ends. Babouris is grown only in the Toupouri area in the Golompoui region. The most important variety of Babouris is the Wale-Masan, whose characteristics are shown in table 15.

TABLE 13.--Characteristics of varieties of wet-season sorghum

| Family | Size | Maturation cycle | Grain color and weight in grams per 1,000 grains | Translucence | Inflorescence | Brown layer |
|---|---|---|---|---|---|---|
| | Meters | Days | | | | |
| Djigaris | 2-3 | 80 | Pink to deep rose, 30-40 | Milky | Compact | Yes. |
| Damougaris type | 2 | 70 | Orange-pink, 20-40 | Milky | Compact and semi-compact. | Yes. |
| Makalaris type | 3 | 80 | Orange-pink to deep rose, 30-40 | Milky | Loose | Yes. |
| Boulbassiris | 2.5-3 | 80-100 | Dull white to grey, 30-40 | Milky | Loose | No. |
| Walaganaris | 2.5-3 | 80-100 | Ivory white to pale straw color, 30-40. | Fairly translucent | Loose | No. |
| Tchergues | 3 | ------ | Yellow, 40-50 | Fairly translucent | Compact | No. |
| Yolobris | 3 | 125 | Ivory white, 30-40 | Translucent | Loose | No. |

TABLE 14.--Characteristics of Mouskouaris transplant sorghum in the Diamare Region

| Types and varieties | Area | Botanical type | Size | Inflorescence | | Peduncle | Grain-- | | | Flour |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Shape | Type | | Color | Translucence | Weight per 1,000 grains | |
| | | | Centi-meters | | | | | BONO style | grams | |
| Safrari: | | | | | | | | | | |
| Touringuel--- | Benoue--- | Durra----- | 140 | Ovoid------- | Compact---------- | Curved---- | Yellow---------- | 2 | 35-60 | White. |
| Darniguel---- | Benoue--- | Durra----- | 150 | Fusiform---- | One-half compact-- | Straight-- | Yellow---------- | 2 | 35-60 | White. |
| Madjeri: | | | | | | | | | | |
| Tchellori---- | Mourel--- | Durra----- | 150 | Fusiform---- | One-half loose---- | Straight-- | White----------- | 2 | 40-50 | White. |
| Tolotolo----- | Mourel--- | Durra----- | 140 | Ovoid------- | Compact---------- | Curved---- | White----------- | 2 | 40-50 | White. |
| Bourgouri: | | | | | | | | | | |
| Gr1: Gassa-- | Tallari-- | Caffra---- | 150 | Ovoid or fusiform. | One-half compact-- | Straight-- | White with brownish tinge. | 0 | 35-55 | Colored. |
| Gr2---------- | Tallari-- | Caffra---- | 150 | Ovoid or fusiform. | One-half loose---- | Straight-- | Fairly dark red--- | 0 | 35-55 | Colored. |
| Gr3---------- | Tallari-- | Caffra---- | 150 | Ovoid or fusiform. | One-half compact-- | Straight-- | Chalk white------- | 0-1 | | |
| Adjagamari----- | Pourdi--- | Durra----- | 140 | Ovoid------- | Compact---------- | Curved---- | Ivory----------- | 2 | 35-60 | White. |
| Soukatari------ | Dalassi-- | Durra----- | 130 | Ovoid------- | Compact---------- | Curved---- | Red--------------- | 2 | 45-55 | White. |
| Mandouweiri---- | Dalassi-- | Durra----- | 130 | Fusiform---- | One-half loose---- | Straight-- | Light brown------- | 2 | 40-50 | White. |
| Ulkeiri-------- | Dalassi-- | Durra---- | 130 | Ovoid------- | One-half loose---- | Straight-- | White and red----- | 2 | 40-50 | White. |

TABLE 15.--Characteristics of Babouris transplant sorghum

| Varieties | Botanical type | Size | Inflorescence | Peduncle | Grain-- | | Flour |
|---|---|---|---|---|---|---|---|
| | | | | | Color | Translucence | |
| | | Centimeter | | | | | |
| Wale-Mansan-- | Caffra-- | 230 | Ovoid; one-half semi-loose. | Straight-- | White-- | 0 | Colored. |
| Madesse------ | Caffra-- | 230 | Ovoid; one-half semi-loose. | Straight-- | Red---- | 0 | Colored. |

Practices vary from one region to another, and no single method of rotation of sorghum and millet is used. In the Mandara Mountains, some farmers alternately cultivate sorghum and millet, and others grow peanuts, which is either the only crop or is interplanted with sorghum. In the cotton-growing area, cotton is alternated with sorghum on heavy soils. On lighter soils, cotton is rotated with peanuts and sorghum, followed by a fallow period of variable duration. The length of the fallow period is inversely proportionate to the density of the population in any given region.

Transplant sorghum is grown every year in areas of clayey soils on lowlands; it is not rotated.

Wet-season sorghum is cultivated in the traditional manner. After the field has been cleared and burned, it is prepared by hoeing. The seed, which is rarely treated before planting, is thinly sown. Hoeing often is not done at the proper time, and seed often is sown somewhat late. These factors explain to some extent the low yield of 350 to 400 kilograms per hectare. Near the villages, some fields are planted more densely and yields are as high as 1,500 kilograms per hectare, according to a study of the village of Gayak by ORSTOM.

In the cotton-growing area a number of fields are plowed. No study has been made to compare the yields in plowed fields with those in unplowed fields.

## Maize

Maize is not extensively grown in North Cameroon, and it is mostly planted near houses for home consumption. About 12,800 hectares is planted to maize annually in the Benoue and Logone-Chari Departments. The yield per hectare is difficult to estimate because part of the crop is eaten fresh.

According to IRAT (now know as ONAREST), maize has not been developed as a cereal because the grain of the local varieties has a tought skin which is difficult to pound into flour. IRAT is working to develop soft-skinned maize.

## Rice

The area in rice is about 10,000 hectares. Rice is principally grown in flooded low-lying areas. In Benoue, however, rice is not irrigated in some areas. The largest of these areas is in the Mayo-Danai Department on a site developed by SEMRY at Yagoua. At N'Dou, in the Logone-Chari Department, there is an experimental rice station. Alongside this station is a second site run by the Lake Chad Basin Commission.

Areas of irrigated rice are grouped into two project sectors: the SEMRY project sector and the N'Dou project sector.

SEMRY project sector: Under the management of the Sector for Experimentation and Modernization of Rice Production at Yagoua, rice fields were laid out with minimal preparation between the Logone and the Mayo Guerleo, a branch of the Logone River that drained the lower part of the rice-growing area. The rice fields were to be dependent on rainfall between June 15 and August 15; after that date, the floodwaters of the Logone River would flood the ricefields. Because of undependable rainfall, however, the system did not work well from 1952 to 1971.

The current project provides for the development of 4,600 hectares for rice cultivation between Yagoua and Dougi. Development includes a completely regulated irrigation system for use in the wet and dry seasons. During the rainy season, water is pumped from the Logone River to the rice fields until the river reaches a level at which gravity is sufficient to ensure the necessary flow of water. During the dry season, the system depends entirely on water pumped to the fields. The site has 5 pumping stations and 18 electric pumps; the water flow is 700 liters per second.

The total area of new land placed in rice production was 1,700 hectares in 1974 and 3,800 hectares in 1975. In 1976 the SEMRY 1 project planned to have 4,600 hectares in rice production.

The area under cultivation during the dry season was 516 hectares in 1973-74 and 845 hectares in 1974-75.

The area under cultivation in the dry season will be limited to 3,000 hectares because of the limited supply of water from the Logone River. The amount of water pumped during the dry season is restricted by an agreement between Chad and Cameroon.

The project area has been divided into basic units of 200 meters by 400 meters to facilitate the work of the tractor. Each unit is surrounded by an irrigator and a ditch.

Each local participant is given a 1/2-hectare lot, but the individual lots are not marked out. Before a unit is put into cultivation, all participants, under the guidance of trained personnel, contour the area. Contours are constructed at intervals of 6 centimeters.

The use of large machinery to prepare the soil each season necessitates the leveling of the contours after each harvest and the construction of new ones before the next crop is planted. The need to construct contours is not always fully understood by the local people, and some mark out their plot by means of a small embankment rather than assisting in preparing the contour.

The varieties cultivated by these methods have a high yield. They require the use of fertilizer. The 2 principal varieties cultivated are IR8 and IR24, whose cycles are about 145 days in season or 175 days out of season. These consecutive cycles of cultivation allow very little time for the preparation of the soil, and extra equipment for plowing must be kept on hand. Experiments with a variety that has a 120-day cycle are being conducted.

Because the soil is compact when dry, it has to be prepared by machinery before sowing or transplanting. To accomplish this, SEMRY owns large 130- to 150-horsepower tractors that are equipped with disk plows. It is sometimes necessary to go over the soil twice with these machines to sufficiently prepare the ground for planting.

Direct sowing was done until 1973 when the rice fields yielded almost no crop at all. This experience rapidly popularized the technique of transplanting. Transplanting is now used throughout the area. It allows more time for ground preparation if there are two growing seasons in succession.

Because the plants are rarely arranged in rows, rotary weeders cannot be used.

Threshing is done manually. It is slow and causes delays when the fields are ready for sowing of the second crop. Therefore, SEMRY is trying to popularize a small rotary thresher which is similar to the Japanese thresher and has proved satisfactory in trials.

Average production in the SEMRY project area was 2,665 kilos of rice per hectare, whereas it was 643 kilos outside the project area. No thorough study has been made to determine how much rice is retained by the grower for his own use. In the project area, SEMRY estimates this to be 10 percent of the total volume produced. According to this estimate, retention for the grower's use is 296 kilos per hectare. The yield for each lot, therefore, is almost 3,000 kilos per hectare. In areas outside the project, if the same quantity per hectare is retained by the grower, the yield averages 940 kilos per hectare.

The results for the 1975 dry season are as follows:

| | | |
|---|---|---|
| Area planted to IR8 and IR24 varieties | 749.5 | hectares |
| Production | 3,158 | tons |
| Yield per hectare | 4,214 | kilos |

If the amount retained for the grower's use is added, a total yield of more than 4,500 kilos of paddy rice per hectare results. This yield is 50 percent higher than the average yield that was posted as acceptable for the project.

SEMRY provides the grower with seedlings, fertilizers, and assistance in land preparation, services for which the grower must pay after harvesting his crop. The costs involved in planting 1/2 hectare are as follows:

| | |
|---|---|
| Rent | 7,100 FCFA |
| Plowing | 3,000 FCFA |
| Seedlings | 4,500 FCFA |
| Fertilizer | 10,100 FCFA |
| Total | 24,700 FCFA |

Upper and lower limits of yield have been set which include most of the farmers' crops. In 1975 exceptional yields of more than 8 tons per hectare were obtained by a few of those who were participating in the project.

Estimated profit from one-half hectare of irrigated rice

| Yield in tons per hectare | Total production in tons | Value in FCFA | Cost in FCFA | Income in FCFA |
|---|---|---|---|---|
| 2.5 | 1,250 | 35,000 | 24,700 | 10,300 |
| 3.0 | 1,500 | 42,000 | 24,700 | 17,300 |
| 3.5 | 1,750 | 49,000 | 24,700 | 24,300 |
| 4.0 | 2,000 | 56,000 | 24,700 | 31,300 |
| 4.5 | 2,250 | 63,000 | 24,700 | 38,300 |

Before August 1975, SEMRY had one outdated rice factory that had a capacity of 1.5 to 2 tons of paddy rice per hour. In August, a second rice factory that has a capacity of 4 tons of paddy rice per hour went into production. These two factories should prove adequate to cope with the increase in production expected in the future.

Refining rice in whitening cones yields a by-product--"cone" flour--which might provide a useful feed for cattle and pigs. Although cone flour sells for only 5 FCFA per kilo, there are few buyers. The flour has a limited storage life, and because SEMRY has no storage facilities this by-product is disposed of by burning. The production of flour from each cone in the old factory was 7 percent of the tonnage of rice processed, or nearly 700 tons in 1975, and most of it was waste.

Estimates of the nutritional value of cone flour have been made at the stock-rearing station at Wakwa. The product tested was a rice flour equivalent to a mixture of the flours produced by the three refining cones. The results of the analysis are:

| Composition | Percent |
|---|---|
| Dry matter | 91.0 |
| Raw protein | 11.5 |
| Fat | 11.0 |
| Bran | 1.0 |
| Digestive proteins | 6.5 |

Results of tests made at Wakwa with cone flour were inconclusive and not wholly satisfactory, probably because the flour is too rich in fatty material for ruminants and, therefore, is not easily digested. Because the cone flour from the different cones varies in fat content it should not be mixed during tests in order for the tests to be meaningful.

Experiments made by Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux (IEMVT) in Madagascar should be referred to in developing the use of the rice flour by-product as a food for livestock.

N'Dou project sector: The N'Dou project sector is 5 kilometers south of Kousseri on the road to Logone Birni. In 1974, there were 90 hectares being managed by the Agricultural Development Center of the Lake Chad Basin Commission. Eighty-two hectares of this area were subdivided into holdings of 1/4 hectare for each operator. The other 8 hectares were used for agricultural experiments.

A nearby area of 500 hectares is used for irrigated rice; irrigation water is pumped from the Logone River. When the rice is harvested, the fields are again planted with another crop of rice that is produced without irrigation. Unlike the SEMRY project, this sector has individual growers who take part in the preliminary work. In both of the N'Dou areas, oxen belonging to the sector are used to plow the fields. The cost of preparing the ground is 10,000 FCFA per hectare.

The principal varieties of rice used are IR8, I520, and IR24. The average yield is 3,500 kilos of paddy rice per hectare. The rice is sold by the growers, mainly in the market at Kousseri, at prices that sometimes are as high as 50 FCFA per kilo. The sector estimates the average selling price at 35 FCFA per kilo.

Costs and production per hectare in the N'Dou sector are as follows. These figures are according to LCBC:

Costs

| | |
|---|---|
| Plowing | 10,000 FCFA |
| Rent | 30,000 FCFA |
| Total | 40,000 FCFA |

Rent covers the cost of seedlings from the nursery, water for irrigation, manure, and insecticides.

| | |
|---|---|
| Production (3,500 kilos x 35 FCFA) | 122,500 FCFA |
| Net Revenue (122,500 FCFA - 40,000 FCFA) | 82,500 FCFA/hectare |

Net revenue is 20,625 FCFA for a small holding of 1/4 hectare. In the dry season the yield is 2,500 kilos of paddy rice per hectare. If costs are identical, net revenue of 11,875 FCFA is possible for each small holding.

The possible annual income from 2 consecutive growing seasons is therefore 32,500 FCFA for 1/4 hectare.

The amount of time per hectare spent at work in each growing season at the N'Dou center is as follows:

| | |
|---|---|
| Transplanting | 60 days |
| Ground clearing | 20 days |
| Dike building | 5 days |
| Irrigation work | 10 days |
| Harvesting | 15 days |
| Threshing | 30 days |
| Total | 140 days |

The net earnings for a day's work on 1/4 hectare is about 464 FCFA [32,500 ÷ (140 x 2 x 1/4)].

About 4,200 hectares are planted to rice in low-lying areas without irrigation. In 1974 in the Babouri region, 200 acres of this crop yielded 900 kilos per hectare. Experiments in the cultivation of short-cycle rice that is rainfed have been made by IRAT and are discussed in the section "Meeting Future Needs."

## Cotton

Cotton has been grown in North Cameroon since 1952 when the Compagnie Francaise pour le Developpement des Fibres et Textiles (CFDT) was established. Cotton has been cultivated in all departments of the Northern province except Adamaoua. Cotton production increased from 11,900 hectares in 1952 to 108,194 hectares in 1969. In 1974 it declined to 65,920 hectares because of several years of drought.

The sectors in the CFDT are grouped into 5 districts: Mora, Maroua, Kaele, Guider, and Garoua. Since 1969 cotton production has tended to move southward where the rainfall is more favorable and a larger and more uniform crop can be expected. In addition to the more favorable rainfall, the use of insecticides and fertilizer has increased yields.

Table 16 shows changes in the amount of land under cultivation, in production, and in yields in the 5 districts since 1969. Garoua is the only district that shows an uninterrupted increase in yields since 1970.

Table 17 shows the area of land planted to cotton in 1974 to which different cultural practices were applied.

The Garoua district has the best overall development, although plowed land is more or less equally distributed throughout all the districts.

The varieties cultivated most widely in 1974 were BJA, 444-2, and L 142-9, which were developed by the Institut de Recherches du Coton et des Textiles Exotiques (IRCT) at Maroua.

The 1975 program called for the use of the following varieties: BJA, 444-2, Coker 417, 3716, 5028, and L 142-9. The characteristics of these varieties are given below.

Characteristics of cotton varieties in 1975 program

| Varieties | Weight per 1,000 grams | Yield (ginning) percentage | Length of fiber in millimeters | Yield (oil) |
|---|---|---|---|---|
| BJA | 9.39 | 39.26 | 29.16 | 18.0 |
| 444-2 | 8.50 | 40.00 | 29.70 | 21.0 |
| Coker 417 | 9.30 | 40.00 | 29.70 | 17.0 |
| 3716 | 8.60 | 39.00 | 29.30 | 18.5 |
| 5028 | 8.00 | 43.00 | 29.30 | 18.5 |
| L 142-9 | 8.50 | 41.50 | 29.50 | 20.0 |
| Glandless | 10.00 | 40.00 | 29.30 | 22.0 |

TABLE 16.--Land under cotton cultivation, production, and yields

PERCENTAGE OF TOTAL AREA CULTIVATED IN COTTON

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| Mora------ | 16.8 | 18.3 | 19.8 | 20.6 | 16.9 | 12.1 |
| Maroua---- | 29.0 | 29.5 | 28.8 | 28.9 | 24.6 | 27.3 |
| Kaele----- | 29.3 | 25.2 | 24.1 | 22.0 | 23.6 | 25.7 |
| Guider---- | 11.2 | 14.3 | 15.0 | 15.7 | 18.0 | 17.6 |
| Garoua---- | 13.7 | 12.7 | 12.3 | 12.8 | 16.9 | 17.3 |

PERCENTAGE OF TOTAL COTTON PRODUCTION

| | | | | | | |
|---|---|---|---|---|---|---|
| Mora------ | 21.3 | 28.8 | 20.3 | 19.6 | 9.9 | 10.1 |
| Maroua---- | 32.8 | 24.1 | 27.3 | 26.9 | 14.3 | 22.2 |
| Kaele----- | 23.3 | 16.1 | 17.6 | 16.5 | 18.7 | 18.3 |
| Guider---- | 13.0 | 18.0 | 21.3 | 20.4 | 20.6 | 16.2 |
| Garoua---- | 9.6 | 13.0 | 13.5 | 16.6 | 36.5 | 33.2 |

YIELDS IN KILOGRAMS PER HECTARE

| | | | | | | |
|---|---|---|---|---|---|---|
| Mora------ | 1,081 | 591 | 446 | 492 | 268 | 508 |
| Maroua---- | 1,040 | 307 | 414 | 481 | 264 | 494 |
| Kaele----- | 676 | 240 | 318 | 387 | 361 | 431 |
| Guider---- | 927 | 474 | 620 | 672 | 520 | 560 |
| Garoua---- | 596 | 386 | 477 | 666 | 980 | 1,165 |

TABLE 17.--Cultural practices applied to land sown to cotton, 1974

| District | Area that was-- | | | | |
|---|---|---|---|---|---|
| | Sown [1] | Plowed [2] | Ridged [2] | Manured [2] | Treated with insecticides [2] |
| | Ha | Ha | Ha | Ha | Ha |
| Mora----- | 7,979<br>(13,500) | 3,414<br>(43) | 1,277<br>(16) | 1,996<br>(25) | 139<br>(2) |
| Maroua--- | 17,987<br>(25,000) | 3,319<br>(18) | 220<br>(1.2) | 3,338<br>(19) | 16<br>--- |
| Kaele---- | 17,047<br>(21,500) | 9,402<br>(55) | 2,541<br>(15) | 2,719<br>(16) | 241<br>(1.4) |
| Guider--- | 10,085<br>(13,500) | 5,453<br>(54) | 1,020<br>(10) | 6,822<br>(68) | 842<br>(8.3) |
| Garoua--- | 11,430<br>(12,000) | 5,764<br>(50) | 6,290<br>(55) | 11,120<br>(97) | 10,403<br>(91) |
| Total-- | 64,528<br>(85,500) | 27,352<br>(42.4) | 11,348<br>(17.6) | 25,995<br>(40.3) | 11,641<br>(18) |

[1] Figures in parentheses represent land area proposed for cultivation by SODECOTON. About 75 percent of the proposed area was sown to cotton.

[2] Figures in parentheses represent the percentage of the area that was sown on which this cultural practice was applied.

The variety "Glandless" has not yet been widely used. The seed, however, can be used for human consumption because of an absence of gossypol, a toxic element generally found in cottonseed.

Coker 417 has higher productivity than BJA in North Cameroon because its early development conforms more closely with the rainfall cycle. When ginned, the 5028 variety has a better yield than BJA.

The varieties for widespread use in 1976 are:

| | |
|---|---|
| Mora Region | Coker or 3716 |
| Maroua Region | |
| Kaele Region | L 142-9 |
| Guider Region | |
| Garoua Region | 5028 |

Different fertilizers are used by SODECOTON in different sectors. The complete fertilizer commonly used has the following composition: nitrogen, 22 percent; phosphorus ($P_2O_5$), 18 percent; potassium ($K_2O$), 14 percent; sulfur, 5 percent; and boron, 0.6 percent. The amounts that are used vary from 100 to 200 kilos of complete fertilizer per hectare, to which 50 kilos of urea is sometimes added.

The fertilizer is subsidized by the Cotton Bank, which derives its funds from 60 percent of the profit of SODECOTON. SODECOTON requires a payment from the farmers for the use of fertilizer and insecticide.

The effect of parasites on cotton varies in different areas of the region; generally, parasites increase from north to south. Parasites cause relatively little damage in the Maroua region because in the natural state there is a parasite on Diparopsis itself. In order of importance the principal parasites are Diparopsis, Heliothis, and Earias.

The experimental treatment of crops with insecticides, which was carried out by IRCT in Maroua, enabled SODECOTON to develop the formula now used. In 1974, 11,641 hectares were treated in the cotton-growing area, principally in the Garoua region, as shown in Table 17. The classic Encrine-DDT method, with the use of T15 equipment, was used to treat 11,200 hectares, and the ULV method was used to treat 400 hectares. The ULV method has an advantage over the Encrine-DDT method because water is not needed on the fields when it is used; however, a larger volume of the product is needed. The ULV method will likely gain in popularity if the local price is not much higher than that of the Encrine-DDT method.

The insecticides sold by SODECOTON are 50 percent subsidized by the Cotton Bank. Equipment used in the treatment belongs to SODECOTON.

Areas plowed for cotton cultivation during the period 1963-74 are as follows:

| | Hectares | | Hectares |
|---|---|---|---|
| 1963 | 10,600 | 1969 | 38,000 |
| 1964 | 12,900 | 1970 | 34,700 |
| 1965 | 17,400 | 1971 | 32,000 |
| 1966 | 23,400 | 1972 | 24,000 |
| 1967 | 25,300 | 1973 | 22,300 |
| 1968 | 28,000 | 1974 | 27,350 |

Because of the meager rainfall, plowed areas have decreased since 1969, when a certain number of oxen were sold.

The use of animals for farmwork generally is developing slowly; only limited progress has been made. The introduction of plows into the area has meant some improvement in the preparation of the soils for crops. The problems of improving farming methods, however, are not yet solved, particularly problems regarding hoeing and weeding. Plowshares used to ridge the ground have been used for several years.

The multicultivator, which is equipped with a plow, ridging apparatus, and weeding teeth, was introduced in North Cameroon in 1975, although multicultivators have been widely used in other parts of West Africa for the past 10 years. Unsatisfactory methods of weeding still cause delays in cultivation, and no satisfactory equipment is in use. The quality of the equipment generally is poor.

The use of oxen in cultivation is closely related to the price of the animals. In about 5 years the price of a pair of oxen has almost doubled to the present price of about 80,000 FCFA.

In some areas, SODECOTON assists in promoting the use of asses in farmwork. SODECOTON sold 460 plows for use with asses in 1974 and expected to sell about 1,000 in 1975; the use of asses, however, is restricted to certain light soils.

SODECOTON subsidizes the machinery needed for use with animals. The current prices are as follows:

| | |
|---|---|
| Plow (AT 38) | 12,000 FCFA |
| Plow (for use with asses) | 6,000 FCFA |
| Multicultivator | 25,000 FCFA (Anticipated price) |
| Cart | 30,000 FCFA |

An average yield of cotton and expected income per hectare has been established for each region. The use and cost of fertilizer and insecticides have been taken into account in developing these statistics.

| Region | Yield kilo/hectare | Average income FCFA/hectare |
|---|---|---|
| Mora | 508 | 18,900 |
| Maroua | 494 | 18,800 |
| Kaele | 431 | 16,400 |
| Guider | 560 | 18,780 |
| Garoua | 1,165 | 32,300 |

The statistics show that the Garoua region is the most profitable for cotton, if careful cultivation techniques are used.

Because no record of man-hours spent on cotton production in the area is available, the monetary value of a day's work cannot be calculated.

The capacity of the six cotton gins in North Cameroon is about 110,000 tons of seed cotton per year. Table 18 shows the equipment used, the tonnage processed, and the yield of ginned cotton for each factory in 1974-75. The total production of fiber was 15,096 tons, which has an average yield of 37.66 percent after ginning. Part of the cotton fiber is used in Cameroon, and the rest is exported.

SODECOTON has two oil-processing plants, one at Kaele and the other at Maroua. The Maroua factory processes cottonseed and groundnuts. The capacity of the Kaele factory is 12,000 tons of cottonseed, and the capacity at Maroua is 15,000 tons of cottonseed and 6,000 tons of groundnuts. The oil produced is refined at these plants and bottled for distribution throughout Cameroon. Cottonseed oil is sold at 200 FCFA a liter under the DIAMAOR label, and peanut oil is sold for 380 FCFA under the ABBIA label.

The processing of cottonseed oil leaves an oil cake by-product. The production of oil cake is about 34.5 percent of the total tonnage of cottonseed that is processed and 53 percent of the total tonnage of groundnuts that is processed.

In 1975, production was as follows:

| | |
|---|---|
| Cottonseed oil | 3,360,000 litres |
| Groundnut oil | 960,000 litres |
| Cottonseed oil cake | 9,500 tons |
| Groundnut oil cake | 1,300 tons |

Most of the oil cake is exported; only slightly more than 1,000 tons are sold in Cameroon. Prices for oil cake at the factory are CFAF 22 per kilo for cottonseed oil cake and CFAF 24 per kilo for groundnut oil cake. The oil cake is available as animal feed. Analyses of oil cake made by the Wakwa station are shown below.

| Composition | Cottonseed oil cake | Groundnut oil cake |
|---|---|---|
| Dry weight | 94 percent | 90 percent |
| Raw protein | 45 to 48 percent | 42 to 43 percent |
| Fats | 13 percent | 6 percent |
| Minerals | 0.9 percent | 0.9 percent |
| Digestible nitrates | 400 grams | 380 grams |

## Groundnuts

The production of groundnuts is second in importance after millet and sorghum and is of greater importance than cotton. No statistics are available to determine the amount of groundnuts traded commercially. As with millet and sorghum, a large part of the crop is kept by the producer for his own use, and trading takes place between small private tradesmen.

Two varieties of groundnuts, in addition to the local varieties, have been popularized by the agricultural services: the late, oil-producing variety (LA 28-206) and the eating variety (GH 119-20).

TABLE 18.--Processing of seed cotton, 1974-75

| Center | Equipment | Amount processed | Yield (ginned cotton) |
|---|---|---|---|
| | Saws | Tons | Percent |
| Kaele | 10x90 | 7,356 | 37.26 |
| Maroua | 3x128<br>3x88 | 10,875 | 37.13 |
| Mora | 3x90 | 2,078 | 36.21 |
| Guider | 3x128 | 6,504 | 37.65 |
| Garoua: | | | |
| 1 | 2x80 | 1,164 | 36.30 |
| 2 | 2x88 | 7,571 | 38.94 |
| Touboro | 2x80 | 4,539 | 38.46 |

Seed supplies are not dependable. This is a serious problem for the farmer, but a project to provide groundnut seeds to farmers is underway. The agricultural services make special provisions for groundnut production in the Benoue and Margui-Wandala districts. In 1974 seed loans amounted to 89 tons in Benoue and 27.5 tons in Margui-Wandala.

Seed loans are generally repaid at harvest time in unshelled groundnuts in a weight 30 percent higher than the weight of the seeds that were borrowed. Because of the poor 1974 harvest, however, the total received in repayment together with earlier unpaid debts was barely 30 percent of what was owed, causing concern for the future of the program.

Groundnut tops are a useful food for cattle and other ruminants and for horses. The ratio of weight of tops to groundnuts in shells is 0.9, which for the 1974 season represents nearly 68,000 tons of greens. Groundnut tops are sold in the marketplaces.

## Cultivation of fruit and vegetables

Market gardens in every large town supply fresh produce, primarily dry-season crops. In the Kousseri region, many market gardens provide the city of N'Djamena with fresh fruit and vegetables.

In 1974 ten areas in the Logone-Chari department were equipped with motor pumps; five are in the agricultural station of Logone Birni, and five are in the Goulfey station. This equipment was acquired through a loan of 4,391,000 FCFA from Fonds National de Developpement Rural (FONADER). In the Diamare region, two motor pumps have also been bought for the station at Meskine, costing 630,000 FCFA each. This cost includes the price of the pumps and the digging of the well.

The extent of areas in Diamare devoted to specific fruit and vegetable crops are given below.

| Crop | Hectares |
|---|---|
| Onions | 200 |
| Pimentoes | 3 |
| Tomatoes | 3 |
| Sorrel | 12.5 |
| Eggplant | 0.3 |
| Carrots | 0.9 |
| Lettuce | 1.2 |
| Mangoes | 103 |
| Guavas | 56 |
| Citrus fruits | 10 |
| Bananas | 23 |

Onions are a very important crop at the agricultural station at Meskine near the Tsanaga, and yields of 8 tons per hectare and higher are reported. Onions are a very profitable crop, and their cultivation is increasing. Most of the crop is sent to the South. Storage and preservation present a problem that has not yet been solved.

## Estimated yields of principal crops

Crop yields vary from one resource area to another, and they vary on unlike associated soils within a resource area. The yield from crops grown under a similar level of management largely depends on available soil moisture, soil fertility, and soil tilth. Management can reduce the amount of water lost through evaporation, plant competition, and runoff. Soil fertility and soil tilth can be improved by returning plant residue to the soil and by applying manure or commercial fertilizer to the soil. Soil erosion and the loss of soil fertility can be controlled by agronomic and mechanical practices.

Levels of management: The wide range in crop yields in the project area is the result of variations in farming methods, including the use of modern agricultural machinery, fertilizer, improved seed, and advanced technology.

Production trials show that the major field crops are highly responsive to management and that increased production is in direct proportion to the level of management.

It is estimated that crop production in North Cameroon can increase rapidly, but that progress will vary greatly by region. Yield estimates are based on three levels of management and on a growing season of average amount and distribution of rainfall. The three levels of management are as follows:

1) Traditional level
   - Use of local crop varieties only
   - No fertilizer
   - Low number of plants per hectare (for example, for maize and sorghum, 8,000 plants per hectare)

2) Improved level
   - Use of improved crop varieties
   - Moderate use of nitrogen and phosphate fertilizers
   - Inextensive use of animal traction
   - Moderate number of plants per hectare--about 1.8 times the traditional number (for example, for maize and sorghum, 14,500 plants per hectare)
   - Use of increased amounts of hand labor--1.25 times the traditional amount

3) Intensive level
   - Use of improved crop varieties
   - Use of optimum amounts of complete fertilizers and selected seed
   - Moderate use of seed treatment and pesticides
   - Optimum use of animal traction
   - High number of plants per hectare--about 2.5 times the traditional number (for example, for maize and sorghum, 20,000 plants per hectare)
   - Use of increased amounts of hand labor--1.5 times the traditional amount
   - Emphasis on crop rotation culture

Estimated yields: Table 19 lists yields of the principal crops that can be attained using the levels of management described. Indicated yields are practical and are attainable by a majority of farmers; they do not represent the highest possible yields. Attainment of maximum yields necessitates the use of exotic and hybrid crop varieties, effective disease control, and intensive measures to insure optimum drainage, particularly late in the growing season.

The soil resource units are grouped into eight treatment groups. The soils in each of the first seven treatment groups are relatively uniform in their suitability for specific crops, treatment needs, response to management, and potential yields. Soils in treatment group 8, eroded soils, are too variable to rate.

## Potential for selected crops

Table 20 shows the potential of soil resource units for growing field crops. The ratings are based on soil limitations, including the hazards of erosion and flooding, and the cost or difficulty in overcoming the limitations. Potential crop yields and returns from investments are also considered.

Ratings for soil resource units are based on the interactions and ratings of the major soils and minor soils. The ratings represent the dominant potential of the resource unit or subunit; for example, a rating of very high indicates the potential in more than half the area. The ratings for subunits give the potential for a particular component soil in the resource unit.

Ratings for irrigated crops apply only if irrigation water of high quality is available at reasonable cost. The ratings for irrigated crops do not reflect the potential for development of an irrigation system.

The terms used to rate potentials are defined in the following paragraphs.

VERY HIGH indicates few limitations to use. The limitations are easily overcome at low cost. Estimated returns from investments for development and production are very high.

HIGH indicates limitations that are easily overcome at moderate cost. Estimated returns from investments for development and production are high.

MEDIUM indicates limitations that are overcome with moderate difficulty, at high cost, or both. Estimated returns from investments for development and production are moderate.

LOW indicates limitations that are overcome with much difficulty, at very high cost, or both. Estimated returns from investments are low or marginal.

VERY LOW indicates limitations that are so difficult to overcome or that require such high cost that use of the soils for the desired crops is nearly precluded.

TABLE 19.--Estimated yields of principal crops under three levels of management

[Dashes indicate that the crop is not generally grown on the soils in the given groups. See text for an explanation of the three levels of management]

| Treatment group and soil resource unit | Level of management | Millet and sorghum | Maize | Cotton (with seed) | Groundnuts (unshelled) | Hulled rice-- | |
|---|---|---|---|---|---|---|---|
| | | | | | | Rainfed | Irrigated |
| | | Kg/ha | Kg/ha | Kg/ha | Kg/ha | Kg/ha | Kg/ha |
| Group 1: Level, flooded, or long-saturated clayey soils; poorly drained. | 1 | 700 | ----- | ----- | ----- | 1,500 | 2,000 |
| | 2 | 2,500 | ----- | ----- | ----- | 2,000 | 4,000 |
| 3--Wet soils in broad depressions. | 3 | 3,600 | ----- | ----- | ----- | 3,000 | 6,500 |
| 5--Vertic alluvial plains. | | | | | | | |
| 6--Floodways and alluvial fans. | | | | | | | |
| 13--Level vertic lowlands. | | | | | | | |
| 19--Sodic and vertic soils on lowlands. | | | | | | | |
| 20--River deposits. | | | | | | | |
| Group 2: Gently sloping clayey soils; adequately drained. | 1 | 600 | 800 | 500 | 450 | 1,100 | 1,500 |
| | 2 | 2,000 | 2,500 | 800 | ----- | 1,600 | 3,000 |
| 12--Undulating vertic uplands. | 3 | 3,200 | 4,000 | 1,600 | ----- | 2,100 | 5,000 |
| 21--Claypan soils on lowlands. | | | | | | | |
| Group 3: Gravelly, shallow, or sloping loamy soils; restricted available water capacity. | 1 | 400 | 500 | 300 | 500 | 800 | 1,000 |
| | 2 | 1,200 | 1,200 | 500 | 800 | 1,200 | 2,500 |
| 9--Loamy soils overlying ironstone layers. | 3 | 2,000 | ----- | 800 | 1,200 | ----- | ----- |
| 22--Shallow upland soils. | | | | | | | |
| 23--Hill and valley complex. | | | | | | | |
| Group 4: Well drained sandy soils. | 1 | 550 | 800 | 400 | 600 | ----- | ----- |
| 17--Sandy soils on uplands. | 2 | 1,700 | 2,800 | 650 | 1,000 | ----- | ----- |
| 18--Sandy soils with rocky hills. | 3 | 2,300 | 5,000 | 1,200 | 2,200 | ----- | ----- |
| 24--Very deep sandy uplands. | | | | | | | |
| 28--Plateau upper slopes. | | | | | | | |
| 29--Plateau summits. | | | | | | | |
| Group 5: Excessively drained or droughty sandy soils. | 1 | 500 | 650 | 400 | 500 | 1,000 | ----- |
| | 2 | 1,700 | 2,200 | 600 | 1,000 | ----- | ----- |
| 4--River levee deposits. | 3 | 2,500 | 3,500 | 1,000 | 1,800 | ----- | ----- |
| 10--Low sandy eolian deposits. | | | | | | | |
| 11--Dunes and depressions. | | | | | | | |
| 14--Foot slopes and outwash deposits. | | | | | | | |

TABLE 19.--North Cameroon--Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Group 6: Stony or sloping shallow soils; very restricted productivity. | 1 | 400 | 400 | ----- | ----- | ----- | ----- |
| 15--Shallow plateau soils and steep mountain slopes. | 2 | 1,300 | ----- | ----- | ----- | ----- | ----- |
| 16--Terraced mountain slopes. | 3 | 1,300 | ----- | ----- | ----- | ----- | ----- |
| 25--Gravelly soils on sloping uplands. | | | | | | | |
| 26--Steep mountain slopes. | | | | | | | |
| 27--Stony steep plateau borders. | | | | | | | |
| Group 7: Mostly flooded sodic soils. | 1 | 600 | 600 | 300 | 350 | 800 | 1,000 |
| 1--Lake Chad shore deposits. | 2 | 1,500 | ----- | 500 | ----- | 1,100 | 2,500 |
| 2--Sodic crests and wet depressions. | 3 | 2,500 | ----- | 800 | ----- | ----- | 4,000 |
| 7--Sodic soils. | | | | | | | |
| Group 8: Eroded soils. | | | | | | | |
| 8--Eroded sodic and vertic soils. (Too variable to rate.) | | | | | | | |

TABLE 20.--Potential of soil resource units for selected crops

| Map symbol | Soil resource unit | Extent | | Rainfed rice | Wet-season cotton and sorghum | Dry-season sorghum | Wet-season millet and groundnuts | Irrigated rice | Irrigated crops other than rice |
|---|---|---|---|---|---|---|---|---|---|
| | | Percent | Hectares | | | | | | |
| 1 | Lake Chad shore deposits | -- | 117,000 | Low | Low | Low | Low | Low | Medium. |
| | Natraqualfs, flooded | 50 | (88,000) | Very low | Very low | Very low | Very low | Very low | Very low. |
| | Tropaquepts, flooded | 40 | (71,000) | Medium | Medium | Medium | Medium | Medium | High. |
| 2 | Sodic crests and wet depressions. | -- | 323,000 | Medium | Very low | Medium | Very low | Medium | Low. |
| | Natraqualfs, flooded | 35 | (113,000) | Very low | Very low | Very low | Very low | Very low | Very low. |
| | Pellusterts, flooded | 30 | (97,000) | Very high | Very low | Very high | Very low | Very high | High. |
| 3 | Wet soils in broad depressions | -- | 243,000 | Very high | Very low | High | Very low | Very high | High. |
| | Tropaqualfs, flooded | 90 | (219,000) | Very high | Very low | High | Very low | Very high | High. |
| 4 | River levee deposits | -- | 86,000 | Low | Low | Low | Low | Low | Medium. |
| | Fluvaquents | 60 | (52,000) | Very low | Medium | Very low | Medium | Very low | Medium. |
| | Fluvaquents, flooded | 25 | (24,000) | High | Very low | Medium | Very low | High | Medium. |
| 5 | Vertic alluvial plains | -- | 141,000 | Very high | Very low | Very high | Very low | Very high | Low. |
| | Pellusterts, flooded | 80 | (113,000) | Very high | Very low | Very high | Very low | Very high | Low. |
| 6 | Floodways and alluvial fans | -- | 415,000 | High | Very low | Very high | Very low | Very high | Low. |
| | Pellusterts, flooded | 40 | (166,000) | Very high | Very low | Very high | Very low | Very high | Low. |
| | Fluvaquents, flooded | 30 | (125,000) | High | Very low | Medium | Very low | High | Medium. |
| 7 | Sodic soils | -- | 381,000 | Low | Very low | Low | Very low | Low | Low. |
| | Natraqualfs | 60 | (229,000) | Low | Very low | Very low | Very low | Low | Very low. |
| | Tropaquents | 20 | (76,000) | High | Very low | Medium | Very low | High | High. |
| 8 | Eroded sodic and vertic soils | -- | 284,000 | Very low | Very low | Very low | Very low | Very low | Very low. |
| | Natraqualfs, eroded | 40 | (114,000) | Very low | Very low | Very low | Very low | Very low | Very low. |
| | Pellusterts, eroded | 35 | (99,000) | Low | Very low | Very low | Very low | Low | Low. |
| 9 | Loamy soils overlying ironstone layers. | -- | 70,000 | Low | Medium | Low | Low | Low | Low. |
| | Haplustalfs, moderately deep. | 40 | (28,000) | Low | Medium | Very low | Medium | Low | Low. |
| | Tropaqualfs, depressed | 30 | (24,000) | Low | Medium | Low | Low | Medium | Medium. |
| 10 | Low sandy eolian terraces | -- | 246,000 | Very low | Medium | Very low | Medium | Very low | Low. |
| | Ustropepts | 60 | (148,000) | Very low | Medium | Very low | Medium | Very low | Low. |
| | Tropaquents | 25 | (62,000) | High | Very low | Medium | Very low | High | High. |

TABLE 20.--North Cameroon--Continued

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11 | Dunes and depressions---------- | -- | 308,000 | Low-------- | Medium----- | Low-------- | Medium----- | Low-------- | Low. |
| | Ustropepts---------- | 40 | (123,000) | Very low--- | Medium----- | Very low--- | Medium----- | Very low--- | Low. |
| | Tropaquents, flooded-------- | 35 | (108,000) | High------- | Very low--- | Medium----- | Very low--- | High------- | High. |
| 12 | Undulating vertic uplands------- | -- | 321,000 | Low-------- | High------- | Medium----- | Medium----- | High------- | Low. |
| | Chromusterts---------- | 50 | (160,000) | Low-------- | High------- | Medium----- | Medium----- | High------- | Low. |
| | Pellusterts---------- | 25 | (80,000) | High------- | Very low--- | Very high-- | Very low--- | Very high-- | High. |
| 13 | Level vertic lowlands---------- | -- | 214,000 | High------- | Very low--- | Very high-- | Very low--- | Very high-- | High. |
| | Pellusterts---------- | 70 | (150,000) | High------- | Very low--- | Very high-- | Very low--- | Very high-- | High. |
| | Chromusterts---------- | 15 | (32,000) | Low-------- | High------- | Medium----- | Medium----- | High------- | Low. |
| 14 | Foot slopes and outwash deposits. | -- | 156,000 | Very low | Very low--- | Very low--- | Low-------- | Very low--- | Low. |
| | Ustifluvents---------- | 35 | (55,000) | Very low--- | Very low--- | Very low--- | Medium----- | Very low--- | Low. |
| | Ustipsamments---------- | 25 | (35,000) | Very low--- | Very low--- | Very low--- | Low-------- | Very low--- | Very low. |
| 15 | Shallow plateau soils and steep mountain slopes. | -- | 287,000 | Very low--- | Very low--- | Very low--- | Low-------- | Very low--- | Very low. |
| | Ustorthents, shallow, gently sloping. | 45 | (129,000) | Very low--- | Very low--- | Very low--- | Low-------- | Very low--- | Very low. |
| | Ustorthents, shallow, steep. | 40 | (115,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 16 | Terraced mountain slopes-------- | -- | 281,000 | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Ustorthents, shallow, terraced. | 80 | (225,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Rockland---------- | 20 | (56,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 17 | Sandy soils on uplands---------- | -- | 205,000 | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| | Paleustults---------- | 60 | (123,000) | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| | Haplustalfs, deep---------- | 20 | (40,000) | Very low--- | Low-------- | Very low--- | Medium----- | Very low--- | Low. |
| 18 | Sandy soils and rocky hills----- | -- | 200,000 | Very low--- | Low-------- | Very low--- | Low-------- | Very low--- | Low. |
| | Paleustalfs---------- | 40 | (80,000) | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| | Ustropepts---------- | 30 | (60,000) | Very low--- | Medium----- | Very low--- | Very low--- | Very low--- | Very low. |
| 19 | Sodic and vertic soils on lowlands. | -- | 548,000 | High------- | Very low--- | Medium----- | Very low--- | High------- | High. |
| | Tropaquents---------- | 50 | (274,000) | High------- | Very low--- | Medium----- | Very low--- | High------- | High. |
| | Pellusterts---------- | 30 | (164,000) | High------- | Very low--- | Medium----- | Very low--- | High------- | High. |
| | Natraqualfs---------- | 20 | (110,000) | Low-------- | Low-------- | Very low--- | Very low--- | Low-------- | Very low. |
| 20 | River deposits---------- | -- | 397,000 | Medium----- | Very low--- | Medium----- | Low-------- | Medium----- | Medium. |
| | Ustifluvents, flooded------- | 65 | (258,000) | Medium----- | Very low--- | Medium----- | Low-------- | Medium----- | Medium. |
| | Pellosterts, flooded-------- | 15 | (60,000) | Very high-- | Very low--- | Very high-- | Very low--- | Very high-- | High. |
| 21 | Claypan soils on lowlands------- | -- | 719,000 | Low-------- | Medium----- | Medium----- | Low-------- | High------- | High. |
| | Tropaqualfs, gently sloping. | 65 | (467,000) | Low-------- | Medium----- | Medium----- | Low-------- | High------- | High. |

TABLE 20.--North Cameroon--Continued

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 22 | Shallow upland soils---------- | -- | 197,000 | Very low--- | Low-------- | Very low--- | Low-------- | Very low--- | Low. |
| | Haplustalfs, shallow-------- | 70 | (138,000) | Very low--- | Low-------- | Very low--- | Low-------- | Very low--- | Low. |
| 23 | Hill and valley complex--------- | -- | 800,000 | Low-------- | Low-------- | Low-------- | Low-------- | Low-------- | Low. |
| | Haplustalfs, deep----------- | 40 | (320,000) | Very low--- | Medium----- | Very low--- | Medium----- | Very low--- | Low. |
| | Tropaquepts----------------- | 30 | (340,000) | Medium----- | Low-------- | Medium----- | Very low--- | Medium----- | Medium. |
| 24 | Very deep sandy uplands--------- | -- | 930,000 | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| | Plinthustalfs--------------- | 70 | (651,000) | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| 25 | Gravelly soils on sloping uplands. | -- | 534,000 | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Ustropepts, shallow--------- | 40 | (214,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Ustorthents, moderately deep. | 30 | (160,000) | Very low--- | Low-------- | Very low--- | Low-------- | Very low--- | Very low. |
| 26 | Steep mountain slopes---------- | -- | 496,000 | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Ustorthents, shallow, steep. | 70 | (347,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Rockland-------------------- | 20 | (99,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 27 | Stony steep plateau borders----- | -- | 535,000 | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Dystropepts----------------- | 40 | (214,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| | Ustorthents, shallow, steep- | 30 | (160,000) | Very low--- | Very low--- | Very low--- | Very low--- | Very low--- | Very low. |
| 28 | Plateau upper slopes---------- | -- | 393,000 | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| | Paleustults----------------- | 60 | (226,000) | Very low--- | Medium----- | Very low--- | High------- | Very low--- | Low. |
| | Haplustults----------------- | 20 | (79,000) | Very low--- | Low-------- | Very low--- | Low-------- | Very low--- | Very low. |
| 29 | Plateau summits----------------- | -- | 122,000 | Very low--- | High------- | Very low--- | High------- | Very low--- | Medium. |
| | Tropohumults---------------- | 70 | (85,000) | Very low--- | High------- | Very low--- | High------- | Very low--- | Medium. |

## Meeting future needs

At the current low rate of population increase, the survey area is expected to have a population of 1.8 million by the year 2000. By that year, the requirement for basic cereals, for example, sorghum and millet, will be 360,000 tons. If current yields are maintained, more than 515,000 hectares of sorghum and millet will be needed, an increase of 130,000 hectares in areas under cultivation. To accomplish this, areas in the northern district now used for other crops or for raising livestock would have to be used for sorghum and millet. In the Benoue Department it would be possible to increase the amount of land under cultivation, but there would probably be a problem of under population.

There are several improvements that can be introduced relatively quickly to improve crop production. These include the earlier or more timely sowing of crops, use of treated seed, improved density of sowing seeds, and weeding regularly and efficiently. These improvements can be accomplished through an educational and demonstration program. When improved varieties become available, they should be introduced.

The current educational and demonstration facilities in North Cameroon will need to be expanded if production is to increase. Changes in farming methods will not come quickly unless it can be demonstrated that improved management practices result in appreciably greater yields. It is recommended that, at least initially, the more successful farmers should be provided training. A program could then be developed to assist these farmers in setting up demonstration plots adjacent to the principal roads to market centers. Direct observation of these plots will stimulate other farmers to improve their methods of farming. Demonstration plots should include those crops that are produced for home consumption and for cash income.

### New varieties

One of the most effective ways to increase yields is the use of better adapted and higher yielding varieties of crops. Some of the most promising of these are discussed in the following paragraphs.

Short-cycle rain-dependent rice: In 1974 IRAT tested 10 varieties of rice that matures in 90 days. These varieties were from Madagascar, Taiwan, and Brazil. Most are highly productive, and trials were continued in 1975 on the most promising varieties.

Sorghum and millet:

a. Wet-season sorghum. To achieve a better ratio of grain to stalk, IRAT is trying to produce early varieties of seasonal sorghum with a high yield and short stem. Such a variety, IRAT 55, has been developed, and it yielded more than 6 tons per hectare at the agricultural station. It also yielded more than 2 tons without using fertilizer and following a cotton crop at the training center at Goyand. This variety has red grains, however, which is a disadvantage because the local people prefer white-grained sorghum.

Attempts at hybridization of local varieties are being made, but no variety has yet been developed that is widely used.

b. Dry-season sorghum. Trials made with Mouskouaris have shown that the deciding factor is the quantity of water that is accumulated and stored in the soil during the rainy season. The present system of transplanting seems the most effective (transplanting in holes that are 15 to 20 centimeters deep). The yield is about 800 to 1,000 kilos of grain per hectare where plant density is 10,000 to 12,000. The building of small dikes is recommended on some soils to hold water in the area as long as possible for maximum infiltration.

Peanuts: The two varieties that trials have shown to be the most productive are the 281206 late variety for the production of oil and the GH 119-20 late variety for eating.

A phosphate fertilizer with 22 percent $P_2O_5$ on soils that have a phosphorus deficiency increased the yield from 700 to 1,250 kilos per hectare.

Cotton: The work done by IRCT has permitted the selection of a number of varieties for use in different areas in North Cameroon, and these have been distributed by SODECOTON.

Yields are determined by methods of cultivation and to a lesser extent by the type of soil. Trials carried out by IRCT show very clearly how improved agricultural techniques result in increased yields. Results of this trial follow.

Experiment carried out at Maroua by IRCT

| Sowing date | Fertilizer | Farming operations and date | Yield in kilos per hectare |
|---|---|---|---|
| 06/8 | No | Weeding 06/27 | 830 |
| 06/8 | Yes | Weeding well done, no ridging 06/27 | 1,400 |
| 06/8 | Yes | Weeding well done, with ridging 06/27 | 1,700 |
| 06/8 | Yes | Weeding poorly done, no ridging 07/24 | 750 |
| 06/8 | Yes | Weeding poorly done, with ridging 07/24 | 750 |
| 07/13 | No | None of the above | 400 |

This information shows that the date of sowing is vitally important and that the next most important factor is weeding. It shows that even when fertilizer is used, if weeding is done inadequately, the yield is almost 50 percent lower than if weeding is done well. If suitable varieties of crops are sown at the proper time and fertilized and weeded as needed, higher yields can be obtained.

Existing projects

There are organizations that have successfully increased the total production of crops, and plans have been made to expand their operations.

SODECOTON is the project for the development of cotton. At the time this survey was made, SODECOTON had been concerned only with the cotton crop, although it can also supervise the crops that are rotated with cotton because the same farming community is involved.

SEMRY is the rice growing project in the region of Yagoua. There is also a second project in the Pous region that has a good chance of success if the yields obtained in Yagoua can be maintained. This organization could also be concerned with the crops grown by the families in the area immediately outside the rice project area.

The N'Dou project has developed more than 100 hectares of rice farmed by local people with the use of draft animals.

The organization dealing with the development of peanut production in the Benoue and Margui-Wandala Departments has had a number of difficulties partly because of the bad growing conditions in 1974, and because it does not have a monopoly on the trade of its product. This organization could, if encouraged, help supply adequate amounts of peanuts for home consumption, for peanut oil, and for the export trade.

Following is a summary of existing projects and future expansions.

1. SEMRY 1
   Place: Yagoua.
   Objective: Development of rice fields: 4,600 hectares in the rainy season, 3,000 hectares in the dry season.
   Expected annual production: 30,000 to 35,000 tons of paddy rice.

2. Rice Project, Logone and Chari
   Place: N'Dou.
   Objective: Development of rice fields: 500 hectares in the rainy season, 330 hectares in the dry season.
   Expected annual production: 2,500 tons of paddy rice.

3. Northeast Benoue Project
   Place: Bibemi, Baikoa, Bere.
   Objective: a) Provision for increased employment (population is expected to increase from current 22,700 to 32,000 by 1978).
   b) Increase of cultivated land from current 8,000 to 15,600 hectares.
   Expected annual production: Cotton----------3,500 tons
   Sorghum----------6,600 tons
   Groundnuts--------1,750 tons

4. Pastureland Project of N'Dro (LCBC)

Place: N'Dro, west bank of the Chari.
Objective: Development of pastureland for cattle grazing, in conjunction with Assale-Serbewel project.
Area: 240 hectares in Pennisetum species and legumes.
Expected annual production: 1,100 fattened cattle.

Projects under study or in preparation

1. Southeast Benoue:

Place: Tchollire area.

| Crop | Present area (hectares) | Projected area (hectares) | Expected annual production (tons) |
|---|---|---|---|
| Sorghum | 10,000 | 9,600 | 10,500 |
| Groundnuts | 2,400 | 2,900 | 2,500 |
| Maize | 950 | 1,700 | 2,500 |
| Rice | 150 | 3,000 | 6,000 |
| Cassava | 650 | 800 | ------ |
| Cotton | 6,600 | 12,000 | 18,000 |

2. West Benoue:

Place: From Demsa in the north to the Poli Mountains.
Expected annual production (tons): Cotton----------6,500
Sorghum--------16,000
Maize----------3,000
Groundnuts-----12,000
Paddy rice------5,000

3. Rice-producing area in Logone and Chari:

Place: Kidam, N'Dou, Goulfey.
Objective: Development of rice fields: 500 hectares in each development at first, then 1,000 hectares.
Expected annual production: 5,500 tons of paddy rice in the first phase; 15,500 tons in the second phase.
Because of the number of projects along the Logone River, obtaining an adequate water supply from the river may be difficult. A considerable amount of water is already being drawn off for the SEMRY 1 Project.

New projects

1. Upper Benoue Valley:

The Lagdo dam, expected to be completed by 1980, will provide electricity and water for the irrigation of land downstream.
Upon completion of the dam, the following areas can be developed:
Lagdo-Nadoura----------10,000 hectares
Mayo-Kebi-Garoua----------20,000 hectares
Garoua-Malape----------10,000 hectares
Faro-Benoue confluence----------18,000 hectares
Total----------58,000 hectares

2. Dams in the Maroua Region (SOGREAH study):

Dams are proposed on the Tsanaga, the Boula, the Gayak, and the Oura Malki Rivers. About 8,000 hectares could be irrigated resulting in a cereal production of 35,000 to 40,000 tons.

3. SEMRY II:

Place: Pous.
Objective: Development of rice fields: 7,000 hectares and a double growing season each year.
Expected annual production: 40,000 to 45,000 tons of paddy rice.

Increased use of animals on farms

It is possible to increase the use of animals in farmwork. The following is a determination of the feasibility of obtaining the necessary animals and equipment at current prices.

The average area of each farm is 1.77 hectares. Because a single team can work an area of 5.31 hectares, a grouping of 3 farms is the unit used for estimating expenses, production, and income.

1) Cost of equipment:

| | |
|---|---|
| 1 pair of oxen | 50,000 F. |
| 1 multicultivator | 25,000 F. |
| 1 yoke | 1,500 F. |
| Total | 76,500 F. |

The multicultivator price is that of one subsidized by SODECOTON. SODECOTON's condition of sale is that half the total will be paid at the time of purchase and the rest at the end of the first harvest. It is presumed that the 3 families can obtain the 12,500 F. necessary to buy the multicultivator. The oxen and yoke can be bought with a FONADER loan repayable over 3 years with an interest rate of 5.75 percent. The successive yearly repayments are 20,131 F., 19,144 F., and 18,147 F.

2) Production:

If a semi-intensive level of management is used that includes use of some organizational facilities, production can be estimated. Management practices include use of selected seed that is treated and that is renewed every 3 years. Production, assuming the cropland is divided as indicated, is estimated below. If the farmland of the three farms is divided, in hectares, as follows:

| | |
|---|---|
| Cotton | 1.50 |
| Groundnuts | 1.11 |
| Sorghum | 2.70 |

then production, in kilograms, would be:

| | |
|---|---|
| Cotton | 1.5 x 1,000 = 1,500 |
| Groundnuts | 1.11 x 1,200 = 1,332 |
| Sorghum | 2.7 x 1,200 = 3,240 |

3) Expenses for oxen:

The animals are given an extra supply of food when working. The allowance for draft oxen doing an average workload is double that given when they are not working. For an ox weighing 300 kilos the requirements are:

UF 2.6 x 2 x 2 = 10.4 UF per day
MAD 0.8 x 300 x 2 = 480 grams

Food for oxen consists of grass, grain sorghum, and cottonseed oil cake. Daily food requirements for one ox are as follows:

| Food | Kg. | MS (kilograms) | UF (units) | MAD (grams) |
|---|---|---|---|---|
| Grass | 50 | 7.5 | 6 | 10 |
| Sorghum | 4 | 3.6 | 3.68 | 23.6 |
| Cottonseed oil cake | 1.2 | 1.12 | 1.08 | 480 |
| Total | 55.2 | 12.22 | 10.76 | 513 |

With the above feed program, requirements of UF are satisfied, and there is a slight excess of MAD. The farm can supply its own sorghum needs, so only the cottonseed oil cake must be bought.

At present, veterinary service is free. The only other expenses are the 400 F. tax on each draft ox and the purchase of natron (native soda) or salt, which costs about 100 F. per animal.

Oxen are used for plowing, hoeing, and the preparing of dikes for an estimated 75 work days per year. The estimates for feed expenses do not assume use of the oxen for hauling vehicles.

Direct expenses for the oxen are therefore:

Oil cake----------1.2 x 75 x 22F = 1,980 F.
Taxes----------400 x 2 = 800 F.
Other----------100 x 2 = 200 F.
Total---------- 2,980 F.

4) Expenses connected with crops:

a.) Seed

Treated cotton seed is furnished each year by SODECOTON. Because sorghum and groundnut seed must be renewed every 3 years, 1/3 of the cost is counted for each year.

Sorghum $\frac{20 \times 2.7}{3} \times 40 = 720$ F.

Groundnuts $\frac{100 \times 1.11}{3} \times 50 = 1{,}850$ F.

b.) Treating of seed
Sorghum--270 F.
Groundnuts--297 F.

c.) Fertilizer
Cotton--Payment to SODECOTON for fertilizer and insecticide:
14,000 x 1.5 = 21,000 F.
Groundnuts--5,000 x 1.11 = 5,550 F.
Sorghum--no fertilizer needed; residual effects of fertilizer on cotton and peanuts is sufficient.

Seed----------2,570 F.
Treatment (of seed)--------567 F.
Fertilizer----------26,550 F.
Total----------29,687 F.

5) Income:

Cotton--1,500 x 45 = 67,500 F.

Peanuts--$(1{,}332 = \frac{100 \times 1.11 \times 2}{3}) \times 35 = 44{,}030$ F.

Sorghum--(The sorghum produced is used mainly as food for the families; three families, on the average, consist of 14 persons.)

For the families: 14 x 200 (kilograms per person per year) = 2,800 kilograms

For seed: $\frac{20 \times 2.7 \times 2}{3} = 36$ kilograms

Total: 3,136 kilograms

Total income from crops sold = 111,530 F.

6) Profits:

| | Costs (F.) |
|---|---|
| Annual feed | 2,980 |
| Cultivation costs | 29,687 |
| Repayments: | |
| First year | 20,131 |
| Multicultivator | 12,500 |
| Total | 65,298 |
| Income from crops sold | 111,530 |
| Total cost | -65,298 |
| Profit | 46,232 |

A team of oxen and the necessary equipment can be bought under the conditions used in this example. Each family would have a profit of 15,410 F.

Livestock

This section discusses the production and management of livestock in the survey area, livestock marketing and meat processing, the hide and skin trade, agro-industrial byproducts and animal feeding, and the taxes and laws relating to the livestock industry. Also discussed are existing herd and flock profiles and production models, major constraints in the production, limitations for livestock production by regions, criteria for rating limitations for livestock production by regions, and special areas of livestock development potential. In addition, some general recommendations for developing the livestock subsector are given.

## Livestock production and management

Areas of cattle production and management in North Cameroon consist of two distinct zones, north and south, without a direct connection between them (see fig. 7). These zones were created by a "cordon sanitaire" that coincides with the northern escarpment of the Adamaoua Plateau at about 8° N. latitude. Cattle from the north are prohibited from crossing this line onto the Plateau to protect the herds of Adamaoua from certain diseases common among northern cattle, especially rinderpest and contagious bovine pleuropneumonia (CBPP). The cordon sanitaire contains several game parks and reserves and is heavily infested with tsetse flies, which prevents the movement of trade cattle from the northern plains to the south.

North Cameroon is part of the Greater Lake Chad Basin production and marketing system. This system is characterized by the seasonal migration of breeding herds, transmission of similar diseases, and movement of trade cattle to traditional markets in Nigeria.

North Cameroon consists of three major livestock regions, which differ mainly in kinds of natural resources. These three regions are the Logone-Chari Department (northern region), the Margui-Wandala, Diamare, and Mayo Danai Departments (central region), and the Benoue Department (southern region) (fig. 7). Each major resource region is further divided into at least two specific resource sectors.

The northern region is divided into two sectors. The first, the Serbewel, borders Lake Chad, and the second is a seasonally flooded area between the Logone and Chari Rivers and the Nigerian border, known locally as "yaeres", which means "dry season grazing" in the Fulani language. Livestock in the region are owned mainly by settled Choa Arab farmers. Their herds and flocks graze the fallow cropland during the rainy season and migrate short distances toward Lake Chad or the yaeres flood plains during the dry season. An estimated 160,000 cattle, belonging mainly to Choa Arab farmers, are in the region. Some 200,000 migratory Mbororo Fulani cattle enter the area for dry-season grazing. The Lake Chad Basin Commission Livestock Development Project, supported by AID, is located in the Serbewel sector.

The central region is divided into two sectors. The first, the Margui-Wandala Department, is a mountainous area heavily populated by Kirdi tribesmen. Livestock is largely limited to a few trypano-tolerant cattle, sheep, and goats. There are special nutritional problems in this area, and the human population suffers from both protein and caloric deficiencies. The second sector, the Diamare and Mayo Danai Departments, is an extensive plain with a dense human and livestock population. In the Diamare Department, livestock owners are mainly Fulbe. In the Mayo Danai Department, Kirdi tribes, mainly Kotoko, Mousgum, and Massa, own livestock. During the dry season most livestock are moved either to the yaeres or to other seasonally flooded areas along the Logone River.

The southern region, the Benoue Department, is divided into two sectors. Most livestock are owned by Fulbe, who are also farmers, but Kirdi people keep a few humpless trypano-tolerant cattle, and nomadic herds enter the area in the dry season. Cattle are the most numerous livestock, but sheep and goats are also important. The sector north of the Benoue River has been largely cleared of tsetse flies through a cooperative program with Nigeria.

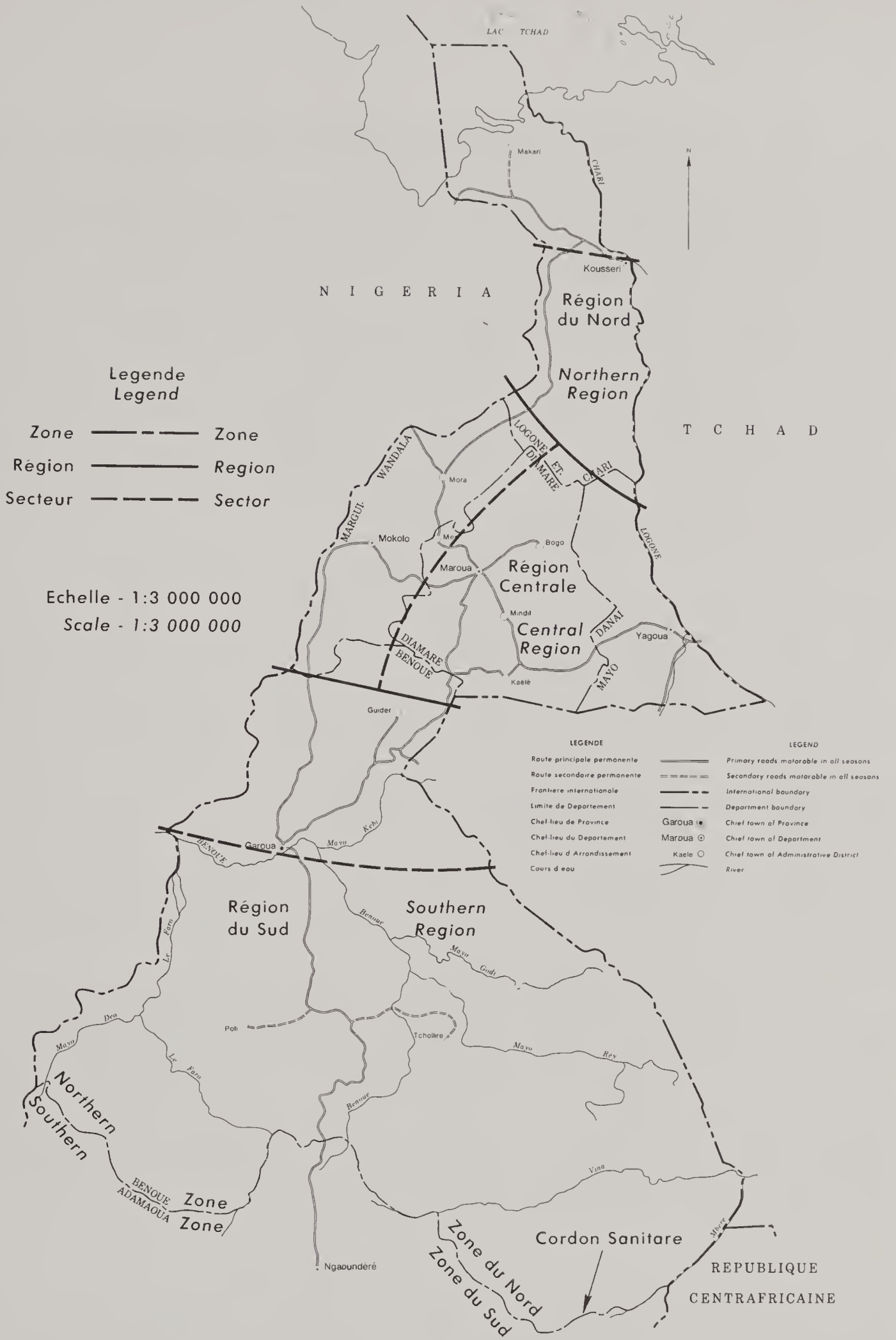



Figure 7 - Régions d'élevage de la partie nord

*Livestock production regions of the northern zone*

The sector south of the Benoue and Mayo Kobi Rivers has about 3,000 resident cattle and a few sheep and goats. About 20,000 Mbororo cattle pass through the area enroute from rainy season grazing in the Yola area of Nigeria to dry-season grazing in the Plateau region in the western part of the Central African Republic. In general, this sector is the last frontier in North Cameroon for agricultural expansion and grazing. However, before livestock production can be developed, an extensive program to eradicate tsetse flies is needed. Because the natural barriers to reinvasion by the flies--including high rainfall, vegetative cover, and a growing game population--are lacking, any extensive program of eradication of tsetse flies would be difficult to maintain. Development projects in the sector require the formulation of a national policy covering agriculture, livestock, tsetse fly control, game management, and tourism. With a national policy, proper land use patterns can be instituted without displacement of residents or disruption of cultural patterns.

## Livestock marketing and meat processing

Livestock marketing combines traditional and modern practices. Controlled traditional markets are well distributed according to demand and availability. More than one-half million head of livestock are sold annually. The larger markets in the central region, especially those in Bogo, Maroua, Gazawa, Kaele, Moulvoudaye, and Guidiguis, account for much of the total sales. Markets in Diamare-Margui-Wandala, Mayo Danai, Benoue, and Logone-Chari normally account for about 66.3 percent, 16.3 percent, 13.9 percent, and 3.5 percent, respectively, of all livestock sales. Market days vary seasonally, but they are established and usually staggered throughout each season. Producers, traders, and butchers are well aware of market-day dates. Markets tend to be specialized; total sales consist of about 25 percent bovines, 37 percent ovines, 36 percent caprines, and 2 percent other species.

Most market activity relates to collecting and handling herd and flock offtake. However, livestock markets, controlled and uncontrolled, are also involved in trade in the Lake Chad Basin. About 85,000 head of trade cattle enter the zone yearly, and slightly over 60,000 head go to Nigerian markets. This production zone has an annual slaughter-cattle deficit of at least 20,000 head, taking into account local canning and airlifting of chilled meat out of the zone. An undetermined but considerable number of slaughter rams and goats also enter the zone each year.

## Hide and skin trade

In 1973, 102,483 cattle hides, 411,105 sheepskins, and 457,095 goatskins were produced in North Cameroon. The better grade hides and skins are exported to Europe, while many of the lower grade hides and trimmings are dried and exported to Nigeria. The small difference in price between higher and lower grade hides does not encourage extreme care in flaying and drying cattle hides.

Statistical data on hides and skins are not an accurate indication of livestock slaughter, because not all such products produced locally enter commercial channels, and many that do probably originate outside the country.

## Agro-industrial byproducts and animal feeding

The two oil mills in North Cameroon are in Maroua and Kaele, and their combined capacity is 25,000 metric tons of cottonseed annually. The potential availability of byproducts is related to the hectarage and yield of cotton. In 1973, 15,000 metric tons of cottonseed were processed. This yielded 2,700 metric tons of oil, 7,000 metric tons of oil cake, and about 5,000 metric tons of hulls. The hulls are a potentially valuable ruminant feed but are used to fire plant boilers. The oil cake is largely exported to Europe, but about 5 percent is sold for local animal feed at a price of 22 FCFA per kilogram. Because it is high in digestible protein, cottonseed cake is an excellent food supplement for ruminants and nonruminants.

Grain sorghum and millet provide enormous amounts of dry-season forage for traditionally owned herds and flocks, and irrigated paddy is well suited to use for animal feed. For example, the irrigated rice project (SEMRY) at Yagoua produced and milled 4,190 metric tons of paddy in the 1973-74 growing season. This produced 320 metric tons of rice bran, a highly nutritious animal feed. The mill management sells this byproduct at 5 FCFA per kilogram, but most of it remains unsold and is discarded. A small amount is used by a local pig producer. Because swine make the best use of rice bran, the Yagoua area is a good area for developing swine production. Plans are underway to expand paddy production in the area to 10,000 metric tons annually by 1976. This would almost triple the amount of rice bran produced in 1973-74.

The dry-season rice straw produced at Yagoua is green and leafy under existing harvesting practices, and it is suitable for use as roughage for ruminant livestock. Because the ratio of paddy to straw on a dry-weight basis is about 2 to 1, about 5,000 metric tons of straw will be produced annually in the Yagoua area by 1976, even though management burns the straw to clear the land. Most tenants in Yagoua also keep livestock, and this livestock would benefit from higher nutrition levels. However, a special effort would be needed to organize and promote its use as animal feed.

The Lake Chad Basin Commission Agricultural Development Center at Kousseri now has 100 hectares in irrigated paddy with plans for expansion to 5,000 hectares. Two crops per year are being produced, and each crop yields up to 4.5 metric tons of paddy per hectare.

The Kirdi tribesmen of Wandala have always sacrificed fattened bulls during Maray, a pagan religious celebration. A young bull, 1 to 2 years old, is placed in a hole in the ground with a thatched cover and is hand-fed for a year or longer. The feed is quite variable and includes green grass, peanut vines, spent grains from local production of beer, sweet potato vines, sorghum stover, grass hay, and natron (a crude mineral deposit obtained from Chad). Since a 20,000 FCFA stocker bull can bring a price of 40,000 FCFA in one year with no cash outlay other than for purchase of the animal, many villagers have commercialized the operation and are now fattening cattle for profit. A 1974 study conducted on 298 families in the mountainous area north of Mokolo revealed that two-thirds were fattening one or more head of cattle.

Similar small-scale fattening operations have potential, but the prospects for large-scale cattle fattening by the Kirdi method are limited.

## Taxes and laws relating to the livestock industry

The taxes and laws regulating the livestock industry are not uniformly applied and generally hold back development. They can result in unreliable statistical data about the industry.

There is no poll tax on sheep and goats, but owners of 1 to 10 cows must pay 200 FCFA per cow annually. Those that own more than 10 head of cattle are assessed 100 FCFA per head. This obviously works against the small holder of cattle. Moreover, this tax structure encourages an imbalance between livestock and forage supply, because taxation is proportionately lower for large herds than for small herds. A 200 FCFA sales tax is levied on animals sold in official or controlled markets and thereby encourages avoidance of such markets. For official export of animals, owners must pay an export tax of 500 FCFA. This tax encourages unofficial, unrecorded export.

There are laws governing the age and sex of animals at the time of slaughter. These are a more serious incumbrance to the livestock industry than taxes, and they are difficult to apply uniformly. In particular, laws restricting the sale for slaughter of breeding females and immature males are difficult to enforce and hinder producers in managing their herds.

## Existing herd and flock profiles and production models

A herd or flock profile consists of herd composition (number by sex and age) and technical coefficients of reproduction and production. A base herd profile that is projected over a period of time yields a production model that describes output under traditional management practices.

Based on all available data, six different production models have been constructed for the livestock industry and include two for cattle, three for sheep, and one for goats. These models are based on herds and flocks of 5,000 females of breeding age.

Cattle production models include those for trypano-susceptible and trypano-tolerant eco-types and associated tribal breeds. The first eco-type includes animals under nomadic and semi-nomadic management and the second includes only sedentary animals. Tables 21 and 22 present the various technical details for cattle production models.

Sheep production models (see tables 23, 24, and 25) cover 3 eco-types (Deserto-Sahel, Sudano-Guinea crossbreds, and Equatorial and Kirdi) of animals under management that varies from migratory to sedentary.

Goat production models are inadequate because of an almost total lack of factual data on the goat species produced. Table 26 describes a production model for Sudano-Guinea crossbred goats under sedentary and semi-migratory management.

## Major limitations in the production phases

Livestock production is defined as the raising or maintaining of domestic animals having usable or exchangeable value, or both, for their yield or services. Production is divided into five specific phases: breeding, nutrition, management, health, and marketing. This division is useful when

TABLE 21.--Trypano-susceptible cattle, baseline herd profile and production model--tribal breeds: Choa Arab, M'Bororo, and Foulbe (nomadic/seminomadic)[1/]

| Herd composition | Mortality | Inventory flow during year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Opening inventory | Additions--births | Losses from all causes | Offtake during year | Closing inventory | |
| | | | | | | Number | Percentage of total herd composition |
| | Percent | | | | | | |
| Brood cows | 7 | 5,000 | ----- | 350 | 300 | 4,350 | 38.8 |
| Other females: | | | | | | | |
| 0 to 1 year old | 26 | 0 | 1,400 | 364 | 0 | 1,036 | 9.2 |
| 1 to 2 years old | 12 | 1,036 | ----- | 124 | 0 | 912 | 8.1 |
| 2 to 3 years old | 6 | 912 | ----- | 55 | 0 | 857 | 7.6 |
| 3 to 4 years old | 6 | 857 | ----- | 51 | 19 | 787 | 7.0 |
| Subtotal | -- | 7,805 | 1,400 | 944 | 319 | 7,912 | 70.8 |
| Stud bulls | 6 | 250 | ----- | 15 | 22 | 213 | 1.9 |
| Other males: | | | | | | | |
| 0 to 1 year old | 27 | 0 | 1,400 | 378 | 0 | 1,022 | 9.1 |
| 1 to 2 years old | 12 | 1,022 | ----- | 123 | 0 | 899 | 8.0 |
| 2 to 3 years old | 6 | 899 | ----- | 54 | 146 | 699 | 6.2 |
| 3 to 4 years old | 6 | 699 | ----- | 42 | 328 | 329 | 2.9 |
| More than 4 years old | 6 | 329 | ----- | 20 | 200 | 109 | 1.0 |
| Subtotal | -- | 3,199 | 1,400 | 632 | 696 | 3,271 | 29.2 |

TABLE 21.--North Cameroon--Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total------- | -- | 11,004 | 2,800 | 1,576 | 1,015 | 11,213 | 100.0 |

1/ Production coefficients are as follows: (1) Bull to cow ratio: 1 to 20; (2) Calf drop: 56 percent; (3) Effective calving rate: 41.2 percent; (4) Cow replacement rate: 13 percent; (5) Bull replacement rate: 15 percent; (6) Age at first breeding: 3½ years; (7) Herd offtake: 9.1 percent; (8) Herd inventory change: ⁺1.9 percent; (9) Herd offtake plus herd increase: 11 percent; (10) Average age and weight of slaughter males: 3½ years and 275 kilograms.

TABLE 22.--Trypano-tolerant cattle, baseline herd profile and production model--tribal breeds: Kapsiki and Poli (sedentary) [1/]

| Herd composition | Mortality | Inventory flow during year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Opening inventory | Additions--births | Losses from all causes | Offtake during year | Closing inventory | |
| | | | | | | Number | Percentage of total herd composition |
| | Percent | | | | | | |
| Brood cows | 10 | 5,000 | ----- | 500 | 250 | 4,250 | 44.2 |
| Other females: | | | | | | | |
| 0 to 1 year old | 22 | 0 | 1,500 | 330 | 0 | 1,170 | 12.2 |
| 1 to 2 years old | 8 | 1,170 | ----- | 94 | 26 | 1,050 | 10.9 |
| 2 to 3 years old | 7 | 1,050 | ----- | 74 | 26 | 950 | 9.9 |
| Subtotal | -- | 7,220 | 1,500 | 998 | 302 | 7,420 | 77.2 |
| Stud bulls | 7 | 250 | ----- | 18 | 118 | 214 | 2.2 |
| Other males: | | | | | | | |
| 0 to 1 year old | 22 | 0 | 1,500 | 330 | 70 | 1,100 | 11.4 |
| 1 to 2 years old | 8 | 1,100 | ----- | 88 | 165 | 847 | 8.8 |
| 2 to 3 years old | 7 | 847 | ----- | 59 | 752 | 36 | 0.4 |
| Subtotal | -- | 2,197 | 1,500 | 495 | 1,005 | 2,197 | 22.8 |
| Total | -- | 9,417 | 3,000 | 1,493 | 1,307 | 9,617 | 100.0 |

[1/] Production coefficients are as follows: (1) Bull to cow ratio: 1 to 20; (2) Calf drop: 60 percent; (3) Effective calving rate: 47 percent; (4) Cow replacement rate: 14 percent; (5) Bull replacement rate: 14 percent; (6) Age at first breeding: 2½ to 3 years; (7) Herd offtake: 13.8 percent; (8) Herd inventory change: +2.1 percent; (9) Offtake plus herd increase: 15.9 percent; and (10) Average age and weight of slaughter males: 2½ years and 170 kilograms.

TABLE 23.--Deserto-Sahel sheep, baseline flock profile and production model--tribal breeds: Zaghawa, Ouda, and Arab (nomadic) [1/]

| Flock composition | Mortality | Inventory flow during year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Opening inventory | Additions--births | Losses from all causes | Offtake during year | Closing inventory | |
| | | | | | | Number | Percentage of total flock composition |
| | Percent | | | | | | |
| Breeding ewes | 7 | 5,000 | ----- | 350 | 700 | 3,950 | 37.6 |
| Other females: | | | | | | | |
| 0 to 1 year old | 20 | 0 | 2,250 | 450 | 0 | 1,800 | 17.1 |
| 1 to 2 years old | 6 | 1,800 | ----- | 108 | 92 | 1,600 | 15.2 |
| Subtotal | -- | 6,800 | 2,250 | 908 | 792 | 7,350 | 70.0 |
| Stud rams | 6 | 200 | ----- | 12 | 36 | 152 | 1.4 |
| Other males: | | | | | | | |
| 0 to 1 year old | 20 | 0 | 2,250 | 450 | 150 | 1,650 | 15.7 |
| 1 to 2 years old | 6 | 1,650 | ----- | 100 | 250 | 1,300 | 12.4 |
| 2 to 3 years old | 6 | 1,300 | ----- | 78 | 1,174 | 48 | 0.5 |
| Subtotal | -- | 3,150 | 2,250 | 640 | 1,610 | 3,150 | 30.0 |
| Total | -- | 9,950 | 4,500 | 1,548 | 2,402 | 10,500 | 100.0 |

1/ Production coefficients are as follows: (1) Ram to ewe ratio: 1 to 20; (2) Lamb drop: 90 percent; (3) Effective lambing rate: 72 percent; (4) Ewe replacement rate: 21 percent; (5) Ram replacement rate: 24 percent; (6) Age at first breeding: 18 months; (7) Flock offtake: 23.5 percent; (8) Flock inventory change: +5.5 percent; (9) Flock offtake plus flock increase: 29.0 percent; and (10) Average age and weight of slaughter males: 2+ years and 60 kilograms.

TABLE 24.--Sudano-Guinea crossbred sheep, baseline flock profile and production model--tribal breed: Choa Arab and Foulbe (semisedentary) [1/]

| Flock composition | Mortality | Inventory flow during year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Opening inventory | Additions--births | Losses from all causes | Offtake during year | Closing inventory | |
| | | | | | | Number | Percentage of total flock composition |
| | Percent | | | | | | |
| Breeding ewes | 10 | 5,000 | ----- | 500 | 750 | 3,750 | 48.8 |
| Other females: | | | | | | | |
| 0 to 1 year old | 35 | 0 | 2,875 | 1,006 | 94 | 1,775 | 23.1 |
| 1 to 2 years old | 8 | 1,775 | ----- | 142 | 175 | 1,458 | 19.0 |
| Subtotal | -- | 6,775 | 2,875 | 1,648 | 1,019 | 6,983 | 90.9 |
| Stud rams | 8 | 250 | ----- | 20 | 142 | 188 | 2.4 |
| Other males: | | | | | | | |
| 0 to 1 year old | 35 | 0 | 2,875 | 1,006 | 1,424 | 445 | 5.8 |
| 1 to 2 years old | 8 | 445 | ----- | 36 | 347 | 62 | 0.8 |
| Subtotal | -- | 695 | 2,875 | 1,062 | 1,813 | 695 | 9.1 |
| Total | -- | 7,470 | 5,750 | 2,710 | 2,832 | 7,678 | 100.0 |

[1/] Production coefficients are as follows: (1) Ram to ewe ratio: 1 to 20; (2) Lamb drop: 115 percent; (3) Effective lambing rate: 75 percent; (4) Ewe replacement rate: 25 percent; (5) Ram replacement rate: 25 percent; (6) Age at first breeding: 14 months; (7) Flock offtake: 37.4 percent; (8) Flock inventory change: +2.8 percent; (9) Flock offtake plus flock increase: 40.2 percent; and (10) Average age and weight of slaughter males: 14 months and 20 kilograms.

TABLE 25.--Equatorial and Kirdi enclave sheep, baseline profile and production model--tribal breed: Kotoko (sedentary) [1/]

| Flock composition | Mortality | Inventory flow during year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Opening inventory | Additions--births | Losses from all causes | Offtake during year | Closing inventory | |
| | | | | | | Number | Percentage of total flock composition |
| | Percent | | | | | | |
| Breeding ewes | 12 | 5,000 | ----- | 600 | 650 | 3,750 | 43.9 |
| Other females: | | | | | | | |
| 0 to 1 year old | 35 | 0 | 4,000 | 1,400 | 100 | 2,500 | 29.2 |
| 1 to 2 years old | 10 | 2,500 | ----- | 250 | 800 | 1,450 | 17.0 |
| Subtotal | -- | 7,500 | 4,000 | 2,250 | 1,550 | 7,700 | 90.1 |
| Stud rams | 10 | 250 | ----- | 25 | 38 | 187 | 2.2 |
| Other males: | | | | | | | |
| 0 to 1 year old | 35 | 0 | 4,000 | 1,400 | 2,000 | 600 | 7.0 |
| 1 to 2 years old | 10 | 600 | ----- | 60 | 477 | 63 | 0.7 |
| Subtotal | -- | 850 | 4,000 | 1,485 | 2,515 | 850 | 10.0 |
| Total | -- | 8,350 | 8,000 | 3,735 | 4,065 | 8,550 | 100.0 |

1/ Production coefficients are as follows: (1) Ram to ewe ratio: 1 to 20; (2) Lamb drop: 160 percent; (3) Effective lambing rate: 104 percent; (4) Ewe replacement rate: 25 percent; (5) Ram replacement rate: 25 percent; (6) Age at first breeding: 13 months; (7) Flock offtake: 48.1 percent; (8) Flock offtake plus flock increase: 50.5 percent; and (10) Average age and weight of slaughter males: 12 months and 18 kilograms.

TABLE 26.--Sudano-Guinea crossbred goat, baseline profile and production model--(sedentary/semimigratory) 1/

| Flock composition | Mortality | Inventory flow during year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Opening inventory | Additions--births | Losses from all causes | Offtake during year | Closing inventory | |
| | | | | | | Number | Percentage of total flock composition |
| | Percent | | | | | | |
| Breeding does--------- | 8 | 5,000 | ----- | 400 | 850 | 3,750 | 42.0 |
| Other females: | | | | | | | |
| 0 to 1 year old--- | 25 | 0 | 4,125 | 1,031 | 269 | 2,825 | 31.6 |
| 1 to 2 years old-- | 7 | 2,825 | ----- | 198 | 777 | 1,850 | 20.7 |
| Subtotal------ | -- | 7,825 | 4,125 | 1,629 | 1,896 | 8,425 | 94.3 |
| Stud bucks---------- | 7 | 200 | ----- | 14 | 36 | 250 | 2.8 |
| Other males: | | | | | | | |
| 0 to 1 year old--- | 25 | 0 | 4,125 | 1,031 | 2,889 | 205 | 2.3 |
| 1 to 2 years old-- | 7 | 205 | ----- | 14 | 141 | 50 | 0.6 |
| Subtotal------ | -- | 405 | 4,125 | 1,059 | 3,066 | 505 | 5.7 |
| Total----- | -- | 8,230 | 8,250 | 2,688 | 4,962 | 8,930 | 100.0 |

1/ Production coefficients are as follows: (1) Buck to doe ratio: 1 to 25; (2) Kid drop: 165 percent; (3) Effective kidding rate: 124 percent; (4) Doe replacement rate: 25 percent; (5) Buck replacement rate: 25 percent; (6) Age at first breeding: 8 to 12 months; (7) Flock offtake: 57.8 percent; (8) Flock inventory change: +8.5 percent; (9) Flock offtake plus flock increase: 66.3 percent; and (10) Average age and weight of slaughter males: 12 months and 18 kilograms.

technology can be used to reduce limitations and improve productive efficiency. The cost of any specific improvement in management must be covered by productive returns, and technology should be applicable and fully acceptable to producers. Within these limits, major limitations in the five production phases of ruminant livestock are presented below. These phases are dynamic factors, and their balance is more important than the level of any particular phase.

Because geographic isolation is a major limitation to overall socio-economic development of the reference production zone, it is largely omitted from consideration of the production phases.

Breeding: This phase of production includes the genetic makeup of an animal, herd, or population. Genetic makeup is determined to be good or bad depending on observed performance under a given set of environmental conditions. These environmental conditions include the level of this phase and its balance with the other four phases.

Under existing baseline practices, breeding is not a major limitation to production among zonal livestock. Although some tribal breeds and some resource areas can be made more productive by greater attention to breeding, more favorable results can be realized through efforts directed at other production phases. In areas recently cleared of tsetse flies, however, more productive cattle could be developed through inmigration or through upgrading with better bulls.

The practice of upgrading the smaller and more southerly tribal-breed sheep with larger Deserto-Sahel rams is a positive step. The Zaghawa tribal breed, however, is a poor choice.

Goats live in an environment that reflects poverty and a degraded land resource base. Their environment favors survival of only the fittest; natural selection, therefore, has produced the best possible gene combination.

Any improvement program for the livestock industry should include breeding as a component of the development plan even though it is not a major limitation to production. This results from the dynamic nature of and special relationship between the production phases. Under improved environmental conditions, breeding would likely become a limiting factor.

Nutrition: This phase covers the total nutritive intake or requirements. Nutrition is the main limitation to baseline livestock production regardless of species and resource area. Traditional producers have long countered feed shortages during the long dry season by the use of migratory or semi-sedentary husbandry practices. However, the animal energy required to reach food and water and the dependence of producers on milk during seasonal migration are serious limitations to productivity. Also, the starving of calves from lack of milk precludes the attainment of production levels beyond a certain point.

Trypano-tolerant cattle in the areas of higher rainfall in the central and southern production regions are exceptions to this limitation. The dry season is much shorter, and forage is relatively plentiful throughout most of the year, although notable mineral deficiencies exist. Production of goats is less limited by poor nutrition than that of cattle or sheep.

In general, nutrition can be improved by managing grazing and opening up areas plagued by tsetse flies.

Management: The extent to which management, husbandry, or day-to-day care of livestock limits baseline productivity is more difficult to assess than the limitations of other phases, because management is largely dictated by production systems, stages of development, species requirements, and producer backgrounds. For example, migratory management of cattle does not limit productivity of an M'Bororo nomad, but it does limit the productivity of the sedentary Kirdi producer who maintains livestock at the scavenger stage of development.

Although management is substandard throughout the northern production zone, its importance must be weighed against the other phases of production. On this basis, management is not considered to seriously limit productivity under baseline conditions. However, improved management practices are needed and should be a high priority in the planning of any development program. Such a development program should give highest priority to cattle management, followed by sheep and then goat management.

Health: Animal health or disease control is the only production phase in this zone that has had Government assistance, but it has been devoted almost entirely to cattle.

The provincial livestock sector is made up of five departments: Benoue, Diamare, Mayo-Danai, Margui-Wandala, and Logone-Chari. This sector has 40 veterinary posts. In the Serbewel-Makary, Bodal-Afade, Fotokol, and Goulfey-Woulki regions four additional posts have been completed and two others are under construction.

At Miskin, Bogo-Moulvoudaya-Guidiguis, Mokolo, and Luggere, six dipping vats for tick control have been established, and another is under construction just north of Yagoua. Fonds d'Aide et de Cooperation is helping the Government to repair existing vaccination parks and is building six new ones.

Veterinary personnel consists of 2 expatriate veterinarians, 2 Cameroon veterinarians in Category A, 19 veterinary agents in Category B, 24 veterinarian aids in Category C, 16 assistant veterinarians in Category D, and 288 laborers and craftsmen.

An animal health school at Garoua graduates 30 students every 2 years. Graduates of this school enter the veterinary service after passing their exams at the Category C level. After completing 1 year of field service, a student can take a second exam. If he passes, he is qualified for the Category B level. After completing several additional years of field experience and passing a more comprehensive examination, the student is qualified for the Category A level.

Vaccines, except those for rabies, are administered free and are supplied by the Farcha Laboratory in N'Djamena, Chad. A double vaccine is used against rinderpest and contagious cattle pleuropneumonia. Single vaccines include those for anthrax, black quarter, rabies, and aftosis or foot and mouth disease. Trypanosomiasis became a major problem during and after the drought, when herds pushed into tsetse fly habitats. Curative (berenil) and prophylactic (trypamidium) drugs are administered to about 70,000 head of cattle annually.

Internal parasites are a major problem in calves and lambs. A major campaign against intestinal parasites in calves was undertaken in Serbewel during 1973, and more than 20,000 head were treated.

Two tsetse fly eradication field units that use spray equipment, transport vehicles, and a road grader are in operation. To expand this operation, six additional technicians have been trained in Nigeria. Additional equipment, supplies, and operational funds are needed to clear areas south of the Benoue River. Eradication of the tsetse fly is complete in Serbewel along the shores of Lake Chad, the Tof-Tof, the Elbeid, and the banks of the Chari River. At a second site that is 37,200 hectares in size and near the villages of Bashso, Gashiga, and Damsa and along the Mayo-Tiel, eradication was completed in 1973.

The major diseases fatal to cattle, especially rinderpest and CBPP, have been brought under reasonable control, and a measure of protection has been provided against trypanosomiasis. Other more destructive diseases that affect sheep and goats, however, have been largely neglected. Disease control measures are more advanced than other production phases under baseline conditions, but veterinary service is severely hampered by a lack of funds. Thus, any new livestock development plan within the survey area must consider further improvement in veterinary services.

Marketing: The timely and orderly offtake of surplus animals from breeding herds and flocks makes up the marketing phase of production. Within the northern production zone, efforts to modernize this phase have had no appreciable long-term effect. This does not mean, however, that marketing seriously limits traditional production. In fact, marketing is less of a limitation than any other phase regardless of livestock species or resource area. This is because a seller's market has developed. There are more prospective buyers than marketable animals.

Any range management program should include a strong marketing component, because marketing is the key in balancing livestock numbers against available forage supplies and assessed range capacity. But the geographic isolation of North Cameroon and its poor prospects for local canning and airlifting of chilled meat preclude early modernization of the marketing phase of production.

Under baseline conditions and for all livestock species, limitations in the five phases of production are, in decreasing order of importance, nutrition, health, management, breeding, and marketing.

In table 27 these limitations are rated by production region. The criteria for the ratings are as follows:

Breeding:

1. None--95 percent conception each year in a short duration.
2. Slight--75 percent conception each year in a short duration.
3. Moderate--50 percent conception each year in a short duration.
4. Severe--Conception every other year and only 50 percent to 75 percent conception annually.
5. Very Severe--Conception every other year and only 25 percent to 50 percent conception annually.

TABLE 27.--Limitations to improving livestock production, by region

[Criteria for rating the limitations are explained in the text]

| Species and region | Breeding | Nutrition | Health | Marketing | Management |
|---|---|---|---|---|---|
| Cattle: | | | | | |
| Northern | Severe | Very severe | Moderate | Severe | Very severe. |
| Central | Moderate | Moderate | Severe | Moderate | Severe. |
| Southern | Moderate | Slight | Very severe | Slight | Moderate. |
| Sheep: | | | | | |
| Northern | Slight | Moderate | Moderate | Slight | Severe. |
| Central | Slight | Moderate | Severe | None | Moderate. |
| Southern | Slight | Slight | Very severe | Slight | Slight. |
| Goats: | | | | | |
| Northern | Slight | Moderate | Slight | Slight | Moderate. |
| Central | Slight | Slight | Slight | None | Moderate. |
| Southern | Slight | Slight | Moderate | Slight | Slight. |

Nutrition:

1. None--No mineral deficiencies and adequate forage supply all year.
2. Slight--Mineral deficiencies during dry season and adequate forage supply all year.
3. Moderate--Mineral deficiencies during the wet season but adequate forage.
4. Severe--Mineral deficiencies during the wet season and inadequate nutritious forage.
5. Very Severe--Mineral deficiencies all year and insufficient forage to maintain animal health.

Health:

1. None--No problem with animal health. No parasites or diseases.
2. Slight--Rare parasites or diseases.
3. Moderate--Parasite treatment needed frequently, but diseases are a minor problem.
4. Severe--Parasite and insect treatment needed frequently, and livestock require immunization.
5. Very Severe--Parasites, insects, and diseases restrict livestock production to those species which are highly resistant.

Marketing:

1. None--No problem; local markets readily available.
2. Slight--Some local marketing, transportation to foreign markets easily obtainable.
3. Moderate--Some local markets, transportation to foreign markets available.
4. Severe--No local markets, transportation to foreign markets available.
5. Very Severe--No easy method to move livestock to markets, no local market, difficult means of moving livestock to distant markets.

Management:

1. None--No management problems; complete control of herd placement and movement.
2. Slight--Sedentary livestock; high degree of control of livestock movement.
3. Moderate--Mostly sedentary livestock; local control of livestock movement.
4. Severe--Migratory herds; some local control of livestock movement.
5. Very Severe--Migratory herds; no local control of livestock movement.

## Special areas of livestock development potential

The relative remoteness and lack of infrastructure are limitations to the development of livestock production in North Cameroon. Development is also limited by population density in many areas and by tsetse flies. Another limitation to the increase in livestock production is the subsistence nature of the industry, which is characterized by overgrazing and by small herds and flocks.

The only area that has substantial potential for extensive and orderly development of livestock is south of the Benoue River; the population density there is only about five persons per square kilometer. Before development begins, however, tsetse flies should be eliminated from this area. It is difficult to eliminate the flies because of the absence of natural barriers to reinvasion. The high rainfall supports a dense vegetative cover, and there is a sizeable and growing game population that spreads the tsetse flies.

There are other areas that have potential for development, but the potential is either broad in nature, limited in scope, or highly specialized. Potential exists for the expansion of veterinary services to all livestock species and for programs that stress the five phases of livestock production.

Local programs that have potential for development of livestock include the use of agro-industrial byproducts in animal fattening by small holders. The hand feeding of cattle by Kirdi villagers in the Wandala region is an example. Irrigation projects for paddy and cotton have considerable potential for supplying the feed used in hand feeding of livestock. Potential exists for increasing the use of rice bran to feed pigs in areas that are near rice mills, especially at Yagoua, where this is already being done. In the yaeres, further livestock development hinges on the development of water resources, but the potential for expansion is considerable. The seasonal use of the area, however, makes it difficult to plan specific livestock improvement programs.

## Suggestions for developing the livestock subsector

In this section, suggestions are made for attaining the potential development of the livestock industry in North Cameroon. These suggestions are not intended to identify specific projects. A government review of laws that affect the livestock subsector should receive high priority. Some laws that appear to be a deterrent to cattle production should be reexamined. Increased livestock production could be encouraged by new laws or amendments to existing laws. Other suggestions for facilitating improved livestock production are listed below.

1. Areas cleared of tsetse flies should be used for livestock development according to land use capability.
2. Veterinary services should be further upgraded and extended to smaller ruminants.
3. Livestock extension services should be developed for the five phases of production: breeding, nutrition, management, health, and marketing.

4. A central station (or stations) is needed to foster adaptive research for the livestock industry.
5. The high reproductive rate of Kotoko sheep warrants consideration of means to improve the herds. The breed may adapt well to areas where the soils consist of heavy clay.
6. Hand fattening of cattle and sheep by small holders and using farm aftermath and agro-industrial byproducts should be promoted.
7. Swine production based on rice bran should be considered.
8. Degreed and nondegreed technical training is needed to support programs in livestock development.

## Range Management

The rangeland in the survey area, its potential for livestock development, and considerations of some range improvement programs are among the topics discussed in this section. Range site descriptions are also given.

### Scope of range

More than 7 million hectares of rangeland are within the survey area. A high percentage of the agricultural income is derived from livestock that graze the native forage. In some areas, grazing of crop residue provides additional nourishment for all classes of grazing animals.

The South Benoue area has good to excellent range because tsetse flies have restricted its use for livestock. The native vegetation in the northern part of the survey area has been greatly depleted by many years of burning, overgrazing, and other detrimental practices. Much of the northern part, including resource areas A, B, C, and D was once perennial grassland and open savannah. This part is now covered with annual grasses, weeds, and unpalatable shrubs, and the amount of forage presently produced is less than half of that originally produced. Range productivity can be increased by management practices that are designed for specific kinds of soils and specific range sites.

Where climate and topography are about the same, differences in the kinds and amounts of vegetation that grow on rangeland are closely related to the kind of soil. Effective management is based on knowledge of the relationships of soils, vegetation, and water.

A range site supports a distinctive potential plant community, or combination of plants, providing it has not undergone any major disturbance. Soils that produce the same kind, amount, and proportion of range plants are identified for each of the range sites. The range site for a particular area can be learned by referring to the soil resource unit map, where the relationships between soils and vegetation have been correlated. Soil properties that determine the capacity of the soil to supply moisture and nutrients to plants have the greatest influence on range plants and their productivity. Soil reaction, salt content, and depth to a seasonal high water table are also important.

Potential production refers to the amount of herbage that can be expected to grow on well-managed range that is supporting the potential plant community. It is expressed in kilograms per hectare of air-dry herbage.

The total air-dry herbage is the amount produced per hectare each year by the potential plant community within reach of grazing animals. All herbage, whether palatable or unpalatable to livestock, is included. Some of the herbage may also be grazed extensively by wildlife.

Scientific names are listed for the grasses, forbs, and shrubs that make up most of the potential plant community on each soil. The amount that can be used as forage depends on the kinds of grazing animals and on the season when the forage is grazed. Generally, not all of the herbage produced is used.

Range management requires, in addition to knowledge of the kind of soil and the potential plant community, an evaluation of the present condition of the range vegetation in relation to its potential production. Range condition is an expression of how the present plant community compares with the potential plant community on a particular kind of soil and range site. The more closely the present kinds and amounts of plants resemble those of the potential plant community, the better the range condition. The usual objective in range management is to manage grazing so that the plants growing on a site are about the same in kind and amount as the potential native plant community for that site. Such management generally results in the maximum production of herbage, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential fits grazing needs, provides wildlife habitat, or provides other benefits and still protects soil and water resources.

For planning purposes, range condition reflects how much change has taken place in the plant community. Range condition classes are defined as follows:

Excellent--The present plant community is the same as the potential plant community.

Good--25 to 50 percent of the potential plant community has been replaced by annuals or other species.

Fair--50 to 75 percent of potential plant community has been replaced by annuals or other species.

Poor--75 to 100 percent of the potential plant community has been replaced by annuals.

Table 28 shows the soil resource unit, the resource area, the natural plant community groups, the range site, the potential annual yield of herbage, and the rating for potential livestock development for each soil resource unit. The potential for livestock development is also displayed, by soil resource unit, on the small scale map at the back of this report.

## Range site descriptions

In this section, some of the range sites in the survey area are described and the natural resource features that combine to make up potential management units are discussed. Each site has potential to produce similar amounts and kinds of plants. These descriptions can be used to aid in planning objectives for livestock management.

Not all of the range sites in North Cameroon are described. Others still need to be studied and described. The descriptions in this survey are preliminary, and the sites need further study.

TABLE 28.--Potential for livestock development, by soil resource unit and range site

| Soil resource unit | Resource area | Natural plant community group[1/] | Range site | Potential annual yields | Potential for livestock development |
|---|---|---|---|---|---|
| | | | | Kg/ha | |
| 1 | A | 1 | Sodic | 500-1,000 | Very low. |
| 2 | A | 1, 12 | Sodic | 500-1,000 | Very low |
| 3 | B | 2 | Flood Plain | 8,000-10,000 | Very high. |
| 4 | B | 1 | Sandy Open Savannah | 1,000-2,000 | Low. |
| 5 | B | 12 | Clayey Savannah | 1,800-3,000 | Medium. |
| 6 | B, C | 12 | Clayey Savannah | 1,800-3,000 | Medium. |
| 7 | C | 1 | Sodic | 500-1,000 | Very low. |
| 8 | C | 1 | Sandy Open Savannah | 1,000-2,000 | Low. |
| 9 | C | 3 | Stony Loamy Savannah | 2,500-4,000 | Medium. |
| 10 | C | 10 | Sandy Dense Savannah | 3,500-5,000 | Medium. |
| 11 | C | 10 | Sandy Dense Savannah | 3,500-5,000 | Medium. |
| 12 | C, F | 12 | Clayey Savannah | 1,800-3,000 | Medium. |
| 13 | C | 12 | Clayey Savannah | 1,800-3,000 | Medium. |
| 14 | D | 7 | Alluvial Granitic Savannah | 1,000-2,000 | Low. |
| 15 | D | 8 | Upland Plateau | 2,500-4,000 | High. |
| 16 | D | 8 | Shallow Rocky Slopes | 1,000-2,000 | Low. |
| 17 | E | 4 | Deep Loamy Savannah | 3,500-6,000 | High. |
| 18 | E | 4 | Stony Loamy Savannah | 2,500-4,000 | Medium. |
| 19 | E | 5 | Meadow | 6,000-8,000 | Very high. |
| 20 | E | 6 | River Bottom | 6,000-8,000 | Very high. |

TABLE 28.--North Cameroon, Africa--Continued

| | | | | | |
|---|---|---|---|---|---|
| 21 | F | 13 | Clay Hardpan Savannah--------- | 1,500-3,000 | Medium. |
| 22 | F | 3 | Stony Loamy Savannah---------- | 2,500-4,000 | Medium. |
| 23 | F, G | 3 | Red Ferruginous Savannah------ | 2,500-4,000 | Medium. |
| 24 | F, G | 4 | Deep Loamy Savannah----------- | 3,500-6,000 | High. |
| 25 | F | 10 | Sandy Dense Savannah---------- | 3,500-5,000 | Medium. |
| 26 | H | 9 | Steep Mountain Savannah------- | 3,000-5,000 | Medium. |
| 27 | H, I | 9 | Steep Mountain Savannah------- | 3,000-5,000 | Medium. |
| 28 | I | 11 | High Plateau----------------- | 4,000-6,000 | High. |
| 29 | I | 11 | High Plateau----------------- | 4,000-6,000 | High. |

1/ See table 10 for a description of the natural plant community groups.

These sites are correlated with the soil resource units and can be located on the maps that show resource areas, soil resource units, natural plant communities, and range sites.

Sandy open savannah--1A

Location: Resource area C.

Topography and elevation: This site is on ridges and mounds adjacent to rivers and streams and on sandy ridges on the flood plains. Elevation ranges from 320 to 600 meters.

Soils: The soils are deep sandy loams and have layers of loam throughout the profile. These soils are subject to severe soil blowing and erosion if overgrazed or if cultivated without the use of proper conservation measures.

Climate: The climate is Sudano-Sahelian and has wet and dry seasons. The average annual rainfall is about 700 millimeters. The wet season is from June to September, but 85 percent of the total rainfall occurs in July and August. There is a period of very hot weather from March to June. The coolest part of the year is November to February.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | Total |
| Mokolo | --- | --- | --- | --- | --- | 6 | 13 | 93 | 300 | 274 | 75 | 39 | --- | --- | 800 |
| Logone-Bionibo | 60 | --- | --- | --- | --- | 42 | 92 | 57 | 156 | 194 | 64 | --- | --- | --- | 605 |

Potential plant community and production: The potential plant community is characteristic of a savannah--dominantly Andropogon gayanus, Pennisetum species, Ctenium species, and Acacia species. The estimated annual production ranges from 1,500 kilograms per hectare in unfavorable years to 2,500 kilograms per hectare in favorable years.

Because the soils are droughty, excessive grazing alters the plant community. Annual grasses replace the perennial species, shortening the period in which green grass grows and thus reducing production on the site.

Forestry potential: This site has a low potential as a source of firewood and poles for small dwellings.

Wildlife habitat: Wildlife potential on this site during the wet season is high.

Potential development for livestock industry: The potential for livestock development is low, although the site can be grazed year-round. The limitations to developing the site for livestock are social factors, lack of water, and the need to reestablish a perennial plant cover where annuals are growing.

This site is grazed during the wet season and during the dry season for as long as vegetation remains.

Sodic--1B

Location: Resource areas A and C.

Topography and elevation: This site is level to gently sloping toward the Benoue River in area C and toward Lake Chad in area A. The elevation ranges from 280 to 500 meters. The lowest elevation is in resource area A and the highest elevation is in resource area C.

Soils: The soils are deep clays that are strongly alkaline.

Climate: The climate is Sudano-Sahelian. The rainfall season starts in late April and ends in early October, but 75 percent of the rainfall occurs in July, August, and September.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Mora | 69 | --- | --- | --- | 13 | 47 | 39 | 356 | 130 | 91 | 15 | --- | --- | 691 |
| Maroua | 74 | --- | --- | --- | 22 | 102 | 45 | 124 | 332 | 133 | 74 | --- | --- | 832 |

Potential plant community and productivity: The potential plant community is savannah-type characterized by species of Acacia trees and the Hyperrhenia rufa and Eragrostis robusta, grasses of the Aristida species, and annual Setarias grasses. The estimated annual production of vegetation within the reach of livestock ranges from 500 kilograms per hectare in unfavorable years to 1,000 kilograms per hectare in favorable years. Present production is less than 50 percent of the potential.

Forestry potential: This site has low potential as a source of firewood and poles for small dwellings.

Wildlife habitat: The potential for game animals is low, because overgrazing by domestic livestock has altered the plant community and thus has reduced the value of this site for game.

Potential for development of livestock industry: The potential for development of the livestock industry is low, because the site has low potential productivity and much of the area requires reseeding. The soils are high in alkali and are difficult to improve. Herds from adjacent countries use this area in transit.

Flood plain--2

Location: Resource area B.

Topography and elevation: This site is level. The Logone River floodwaters extend up to 50 kilometers in width and to a height of 1 meter. Elevation ranges from 300 to 350 meters.

Soils: The soils are heavy clays that have wide deep cracks during the dry season.

Climate: The climate is Sudano-Sahelian and has two distinct seasons. A brief wet season begins in mid-April and ends early in October. At Logone-Birni and Waza, 70 percent of the rainfall occurs in August and September. At Yagoua, 90 percent occurs in the period June through September.

The dry season is longer than the wet season, and it is about 1 month longer at Logone-Birni than at Yagoua, where the rains continue until mid-October.

There is not a large variation in temperature, but the period from February through June has the highest temperatures. The hottest months are April, May, and June.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Logone-Birni | 44 | --- | --- | --- | 6 | 73 | 37 | 168 | 218 | 52 | --- | --- | --- | 548 |
| Waza | 60 | --- | --- | --- | 42 | 92 | 57 | 156 | 194 | 64 | --- | --- | --- | 605 |
| Yagoua | 57 | --- | --- | --- | 26 | 57 | 216 | 253 | 296 | 126 | 14 | --- | --- | 988 |

The rainfall itself has little influence on the vegetative growth, but the annual 4-month period of flooding has great influence.

Potential plant community and production: The potential plant community is characteristic of an open grassland and includes Hyperrhenia rufa, Sporobolus pyramidalis, Seteria palidifusca, Rottobellia exaltata, Echinochloa pyramidalis, Echinochloa stagnia, Oryza barthii, Sorghum aethiopiem, and Sorghum arundinaceum. The dominant species are Hyperrhenia rufa and Oryza barthii. These plants are fire-resistant, and when mature they are not palatable to livestock. No woody species are now on the site. Sorghum species are dominant in disturbed areas and in areas of recent silt deposits. The more palatable plants, for example, Echinochloa pyramidalis and Sporobolus pyramidalis, are in channeled areas and in the areas distant from water. During drought years, when the Logone River does not flood all of the plain, the vegetative growth is drastically reduced.

This site has one of the highest forage yields in North Cameroon. Production is 8,000 kilograms per hectare in unfavorable years and 10,000 kilograms in favorable years. However, only the finer leaves of mature plants are palatable, and these make up a low percentage of the total.

Wildlife and livestock annually leave the yaeres for the higher, sandy range sites because of the clayey soils and the flooding that occurs from May through September. This migration provides time for grasses to grow before the grazing animals return. The continued burning of the mature dry growth, however, and the heavy grazing of the regrowth has weakened the plants on much of this site. Present range condition is poor to good, and most sites are in fair condition. Because much of the area does not have water for livestock, the sites that are in good condition are grazed for only short periods. Areas near permanent sources of water are in poor condition.

Forestry potential: Flooding and the repeated burning by hunters and herders have prevented woody vegetation from growing on the site.

Wildlife habitat: This site is on the flood plain called the "yaeres." This flood plain is a vast grassland that has supported large herds of wildlife for hundreds of years and thousands of cattle in recent years for short grazing periods. This range site includes most of the Parc National de Waza. Isolated patches of trees and shrubs grow on humps or small rises on the plain.

Potential development for livestock industry: The potential for livestock industry development is very high. Although the period of inundation is the most severe limitation, natural irrigation can maintain the site in high productive capacity. Development of livestock water facilities will insure efficient use of this site.

Stony loamy savannah--3A

Location: Resource areas C, E, and F.

Topography and elevation: This site consists of steep areas on the small mountains rising out of the valley and plains. Elevation ranges from 500 to 1,000 meters.

Soils: The soils are shallow to deep, steep stony loams.

Climate: The climate is similar to the Guineo-Sudanian type and has two distinct seasons. The season of rainfall begins in early April and ends in late October, but 85 percent of the total rainfall occurs in June, July, August, and September. In this period, more than 100 millimeters of rain falls each month. The dry season extends from late October to early April. Maximum temperatures occur during February and May. The temperature lowers when the rain starts, and it gradually rises after the rain ends.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Garoua | 47 | --- | --- | --- | 15 | 51 | 110 | 178 | 269 | 338 | 71 | --- | --- | 1,032 |
| Bedjouma | 52 | --- | --- | --- | 31 | 82 | 118 | 216 | 275 | 276 | 41 | --- | --- | 1,039 |

Potential plant community and production: The potential plant community is characteristic of a natural savannah on steep slopes. The species that characterize the plant community are Hyperrhenia rufa, Andropogon gayanus, Pennisetum species, Acacia senegal, and Balanites aegyptica. The estimated annual production of vegetation ranges from 2,500 kilograms per hectare in unfavorable years to 4,000 kilograms per hectare in favorable years.

Forestry potential: This site has moderate potential as a source of firewood and poles for small buildings.

Wildlife habitat: The potential for big game animals is moderate, but game is not common on this site because of severe social limitations.

Potential development of livestock industry: The potential for livestock development is medium. Limitations are steep slopes and stony soils.

Red ferruginous savannah--3B

Location: Resource areas F and G.

Topography and elevation: Slopes on this site range from 2 to 30 percent, but are mostly less than 5 percent. Elevation ranges from 600 to 900 meters.

Soils: The soils are deep, red sandy loams that have iron-cemented pans.

Climate: The climate is Guineo-Sudanian and has two seasons. In this extreme southeastern section of the survey area, the rainy season is five months long. More than 80 percent of the yearly rainfall occurs in June through September, and during this period the rainfall exceeds 100 millimeters each month. The dry season usually ends late in March or early in April.

The temperature is highest in February through June and is moderate for the rest of the year.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Tchollire | 75 | --- | --- | --- | 49 | 96 | 130 | 218 | 271 | 258 | 56 | --- | --- | 1,078 |
| Touboro | 75 | --- | --- | 13 | 54 | 77 | 121 | 250 | 242 | 321 | 84 | --- | --- | 1,162 |

Potential plant community and production: The potential plant community is characteristic of a natural savannah and is mainly Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia species, Ficus species, Commiphora africana, and Seleracarya bierre. The estimated annual plant production is 2,500 kilograms per hectare in unfavorable years and 4,000 kilograms per hectare in favorable years.

Forestry potential: The potential for construction lumber is moderate because of the shallow soils and the hard, iron-cemented pan. The potential is high for firewood and for poles for small buildings.

Wildlife habitat: The potential is very high for wildlife.

Potential development for livestock industry: The potential for the livestock industry is medium. Limitations to development are lack of water for livestock during the dry season and insects during the wet season.

Deep loamy savannah--4

Location: Resource areas E, F, and G.

Topography and elevation: Slopes on this site range from 1 to 5 percent but are mostly 2 percent. Elevation ranges from 300 to 900 meters.

Soils: The soils are moderately deep to deep loams.

Climate: The climate is Guineo-Sudanian and consists of a rather long wet season and a shorter dry season. Over 80 percent of the average yearly rainfall occurs from June to September, and the monthly rainfall during this period exceeds 100 millimeters. The dry season extends from late October to late March. The temperature is highest in February through June and is moderate for the rest of the year. The temperature is coolest in November through January.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Tchollire | 75 | --- | --- | --- | 49 | 96 | 130 | 218 | 271 | 258 | 56 | --- | --- | 1,078 |
| Touboro | 75 | --- | --- | 13 | 54 | 77 | 121 | 250 | 242 | 321 | 84 | --- | --- | 1,162 |

Potential plant community and production: The potential plant community is characteristic of a natural savannah and is mainly Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia species, Ficus species, Commiphora africana, and Seleracarya bierre. The estimated annual production of vegetation ranges from 3,500 kilograms per hectare in unfavorable years to 6,000 kilograms per hectare in favorable years.

Forestry potential: The potential for all types of forestry products is high.

Wildlife habitat: The potential for all types of wildlife is high.

Potential development for livestock industry: The potential for the livestock industry is high. Tsetse fly infestation, however, is a severe limitation.

Meadow--5

Location: Resource area E.

Topography and elevation: Topography consists of the low level wetlands of the upper Benoue River and Faro River basins. Elevation ranges from 200 to 300 meters.

Soils: The soils are clays that commonly are wet from seepage and springs.

Climate: The climate is Guineo-Sudanian. The wet season extends from early in April to late in October and the dry season extends from late in October to late in April. Eighty percent of the average annual rainfall occurs in June to September. In this period over 100 millimeters of rain falls each month. The highest temperatures occur from February to June, and the lowest are in November through January.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Tchamba | 59 | --- | --- | --- | 49 | 45 | 182 | 332 | 265 | 287 | 99 | --- | --- | 1,259 |
| Sanguere | 63 | --- | --- | --- | 25 | 77 | 239 | 175 | 209 | 179 | 30 | --- | --- | 934 |

Potential plant community and production: The potential plant community is characteristic of an open savannah that has widely scattered trees. The main plants are Andropogon gayanus, Echinochloa pyramidalis, Sporobolus pyramidalis, Hyperrhenia rufa, Panicum species, and Cyperus species. The estimated annual production ranges from 6,000 kilograms per hectare in unfavorable years to 8,000 kilograms in favorable years. The natural wetness of the soil has a greater influence on the plant community than does the amount of annual precipitation.

Forestry potential: The potential for forest products is low because of excessive moisture.

Wildlife habitat: The potential for wildlife is high, especially for waterfowl and animals that are adapted to water.

Potential development for livestock industry: The potential for livestock is very high. Soil wetness and insects are limitations.

River bottom--6

Location: Resource area E.

Topography and elevation: Topography consists of the flood plains of the Benoue and Faro Rivers and Mayo Kebi. The site remains flooded for 4 to 5 months each year. Elevation ranges from 160 to 200 meters.

Soils: The soils are clayey alluvial river deposits.

Climate: This site has a Guineo-Sudanian climate. The wet season lasts from early in April to late in October, but more than 80 percent of the annual precipitation occurs in June to September. In this period, more than 100 millimeters of rain falls each month. The dry season lasts from November through March. The temperature is highest in February through June and lowest in November through January.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Garoua | 47 | --- | --- | --- | 15 | 51 | 110 | 178 | 269 | 338 | 71 | --- | --- | 1,032 |
| Tchamba | 59 | --- | --- | --- | 49 | 45 | 182 | 332 | 265 | 287 | 99 | --- | --- | 1,259 |
| Sanguere | 63 | --- | --- | --- | 25 | 77 | 239 | 175 | 209 | 179 | 30 | --- | --- | 934 |

Potential plant community and production: The potential plant community is characteristic of a grassland that has scattered trees and that is mainly Andropogon gayanus, Hyperrhenia rufa, Echinochloa pyramidalis, Sporobolus pyramidalis, Panicum species, and Mimosa species. The estimated annual production ranges from 6,000 kilograms per hectare in unfavorable years to 8,000 kilograms per hectare in favorable years. The long period of flooding influences the potential plant community more than does the precipitation.

Forestry potential: The potential for forest products is low.

Wildlife habitat: The potential for wildlife is high, especially for waterfowl and water-loving animals.

Potential development for livestock industry: The potential for livestock is very high. Long periods of flooding and insects during the wet season are severe limitations.

Alluvial granitic savannah--7

Location: Resource area D.

Topography and elevation: The topography is gently sloping. This site lies between steep mountain slopes and clayey flats in the valley bottom. Elevation ranges from 600 to 1,200 meters.

Soils: The soils are of granitic origin. They are deep and somewhat excessively drained. There are stratified sandy and loamy layers throughout the profile.

Climate: The climate is Sudano-Sahelian and has wet and dry seasons. The wet season starts in April and ends in October, but about 85 percent of the annual rainfall occurs in July, August, and September. The hottest temperatures occur in March and April.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Mokolo | -- | --- | --- | --- | 6 | 13 | 93 | 300 | 274 | 75 | 39 | --- | --- | 800 |
| Bourha | -- | --- | --- | --- | 130 | 69 | 97 | 141 | 365 | 208 | 55 | --- | --- | 1,065 |
| Douroum | 62 | --- | --- | --- | 31 | 41 | 178 | 207 | 336 | 203 | 11 | --- | --- | 1,007 |

Potential plant community and productivity: The potential plant community is characteristic of a natural savannah and is dominantly trees of the Ficus and Acacia species and Balanites aegyptica and the grasses Hyperrhenia rufa and Ctenium elegans and grasses of the Pennisetum species. The estimated annual production ranges from 1,200 kilograms per hectare in unfavorable years to 2,000 kilograms per hectare in favorable years. Present production is less than 50 percent of the potential.

Forestry potential: This site has medium potential as a source of firewood and poles for small dwellings.

Wildlife habitat: The potential for habitat for partridge and other game birds is good. Big game animals are not common on this site because of excessive grazing by domestic livestock.

Potential development for livestock industry: The potential for livestock development is low because of the droughty soils, the low potential production, and the dense population.

Shallow rocky slopes--8A

Location: Resource area D.

Topography and elevation: Slopes on this site range from 30 to 70 percent. Elevation ranges from 600 to 1,200 meters.

Soils: The soils are shallow gravelly loams. Large granitic rocks and boulders outcrop at the surface.

Climate: The wet season lasts from April to October, but 85 percent of the precipitation occurs in June through September. In this period, 100 millimeters or more of rain falls each month. The dry season, starting in October and ending in April, is of about the same length as the wet season. The temperature is highest in February through June and is coolest in November through January. The average temperature is lower than that of the plains.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Mokolo | -- | --- | --- | --- | 6 | 13 | 93 | 300 | 274 | 75 | 39 | --- | --- | 800 |
| Bourha | -- | --- | --- | --- | 13 | 69 | 97 | 141 | 365 | 208 | 55 | --- | --- | 1,065 |
| Douroum | 62 | --- | --- | --- | 31 | 41 | 178 | 207 | 336 | 203 | 11 | --- | --- | 1,007 |

Potential plant community and production: The potential plant community is characteristic of an open savannah and is dominantly Hyperrhenia rufa, Heteropogon contortus, Andropogon gayanus, Aristida species, Ficus species, Balanites aegyptica, and Acacia species. Annual production is low, ranging from 1,000 kilograms per hectare in unfavorable years to 2,000 kilograms in favorable years. At present the site is in poor condition because of heavy use by livestock, past cultural practices, and present harvesting of forage by hand to feed sacrificial cattle, which are fattened in pits.

Forestry potential: This site has medium potential as a source of firewood and poles for small buildings.

Wildlife habitat: The potential for wildlife is low because of the high population density and the steep slopes.

Potential development for livestock industry: The potential for livestock development also is low because of the high density of population and the steep slopes.

Upland plateau--8B

Location: Resource area D.

Topography and elevation: Topography consists of an undulating plateau that has numerous volcanic extrusions. Elevation ranges from 600 to 1,200 meters.

Soils: The soils are shallow to moderately deep gravelly loams.

Climate: The wet season lasts from April to October, but 85 percent of the precipitation occurs in June to September. In this period, more than 100 millimeters of rain falls each month. The temperature is highest in February to June and is lowest in November to January. The average temperature is slightly lower than that at lower elevations on the plains.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Bourha | -- | --- | --- | --- | 130 | 69 | 97 | 141 | 365 | 208 | 55 | --- | --- | 1,065 |
| Douroum | 62 | --- | --- | --- | 31 | 41 | 178 | 207 | 336 | 203 | 11 | --- | --- | 1,007 |

Potential plant community and production: The potential plant community is characteristic of a grassland and is dominantly Hyperrhenia rufa, Andropogon gayanus, Aristida species, and Pennisetum pedicellatum. Annual production ranges from 2,500 kilograms per hectare in unfavorable years to 4,000 kilograms in favorable years. This site remains in grassland. Most trees are in swales and near streams where the soils are deeper.

Forestry potential: In the swales and on the deeper soils, the potential of this site as a source of firewood and building poles is high.

Wildlife habitat: Potential for wildlife is moderate.

Potential development for livestock industry: The potential for livestock development is high. The main limitation is the availability of water for livestock.

Steep mountain savannah--9

Location: Resource areas H and I.

Topography and elevation: Slopes on this site range from 15 to 70 percent but are generally more than 30 percent. Elevation ranges from 900 to 1,600 meters.

Soils: The soils have a coarse loamy surface layer and a fine loamy subsurface layer. Outcrops of rock and iron are common.

Climate: The climate is Guineo-Sudanian. The wet season is long, but 85 percent of the precipitation occurs from May to September. In this period, 100 millimeters or more of rain falls each month. The dry season is shorter and lasts from late October to early April. The temperature is highest in March to June and lowest in November to February. The average temperature is lower than that at the lower elevations.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Tchollire | 75 | --- | --- | --- | 49 | 96 | 130 | 218 | 271 | 258 | 56 | --- | --- | 1,078 |
| Soli | 97 | --- | --- | --- | 89 | 98 | 265 | 294 | 268 | 376 | 32 | --- | --- | 1,422 |
| Nbang | 90 | --- | 17 | 19 | 166 | 338 | 120 | 185 | 304 | 250 | 57 | --- | --- | 1,456 |

Potential plant community and production: The potential plant community is characteristic of a natural savannah and is dominantly Hyperrhenia rufa, Imperata species, Pennisetum species, Panicum species, Andropogon species, Eragrostis species, Anona arenara, and Crossopteryx species. Annual production ranges from 3,000 kilograms per hectare in unfavorable years to 5,000 kilograms per hectare in favorable years.

Forestry potential: This site has high potential as a source of firewood and building poles.

Wildlife habitat: The potential for wildlife is medium.

Potential development for livestock industry: The potential for livestock development is medium. Steep slopes, insects, diseases, and difficulty in reestablishing the potential plant community are very severe limitations.

Sandy dense savannah--10

Location: Resource areas C and F.

Topography and elevation: This site consists of wind-formed terraces that have an undulating surface and low swales between dunes. Elevation ranges from 320 to 600 meters.

Soils: The soils are deep sands on the terraces, heavy clays in the swales, and gravelly sandy loams on sloping uplands.

Climate: The wet season lasts from April to September, but 80 percent of the precipitation occurs in June to September. In this period, 100 millimeters or more of rain falls each month. The dry season is longer than the rainy season. The temperature is highest in February through June and coolest in November through January.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Yagoua | 57 | --- | --- | --- | 26 | 57 | 216 | 253 | 296 | 126 | 14 | --- | --- | 988 |
| Guider | 57 | --- | --- | --- | 10 | 47 | 80 | 423 | 225 | 185 | 51 | --- | --- | 1,021 |

Potential plant community and production: The potential plant community is characteristic of a dense savannah and is dominantly Hyperrhenia rufa, Pennisetum pedicellatum, Andropogon gayanus, Ctenium canesiens, Acacia species, Ficus species, Commiphora africana, and Seleracarya bierre. Annual production ranges from 3,500 kilograms per hectare in unfavorable years to 5,000 kilograms per hectare in favorable years.

Forestry potential: This site has medium potential as a source of firewood and poles for small buildings.

Wildlife habitat: The potential for wildlife is moderate.

Potential development for livestock industry: The potential for livestock production is high. The only limitation is the moderate difficulty in reestablishing the potential plant community.

High plateau--11

Location: Resource area I. This site is along the north edge of the Adamaoua Plateau.

Topography and elevation: The topography is characterized mainly by a rolling, hilly plateau where slopes are smooth. Small volcanic cones dot the landscape. Elevation ranges from 1,000 to 1,600 meters.

Climate: The climate is Guineo-Sudanian. The season of rainfall is the longest in the survey area. On the high plateau, the wet season begins late in February or early in March and ends late in October. In April through September, monthly rainfall exceeds 100 millimeters and is fairly well distributed. The dry season is 4 to 5 months long.

Because of the high elevation of the plateau, the average temperature is a few degrees cooler than at lower elevations. Temperatures are generally cool the year round.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Nbang | 90 | --- | 17 | 19 | 166 | 338 | 120 | 185 | 304 | 250 | 57 | --- | --- | 1,456 |

Potential plant community and production: The potential plant community is characteristic of an open savannah. Open areas are covered by grass, and a dense cover of trees is in swales and along drainageways. Many of the woody species are palatable to livestock. Woody species include Bridelia species, Gussonia barteri, Erythrina sigmoidea, Ficus thonnigii, Gardena ternifolia, Lannen schimperi, Leea guineensis, Maesa lanceolata, and Tricalysa okelensis. Grasses in the plant community are Panicum phragmitoides, Andropogon gayanus, Hyperrhenia rufa and other Hyperrhenia species, Setaria species, Schizachyrium brevifolium, Imperata cylindrica, Pennisetum species, and Sporobolus species. Annual production of herbage within reach of livestock ranges from 4,000 kilograms per hectare in unfavorable years to 6,000 kilograms in favorable years.

Forestry potential: The potential for various wood products is high because of high elevation, high rainfall, and cool climate.

Wildlife habitat: The potential for wildlife is high, and many species of African wildlife are adapted.

Potential development for livestock industry: The potential for livestock development is high. The potential for livestock meat production is high if water sources for livestock are developed and insects are controlled.

Clayey savannah--12

Location: Resource areas A, B, C, and F.

Topography and elevation: Low-lying areas that are subject to flooding during the wet season range in elevation from 300 to 600 meters.

Soils: The soils in the alluvial flood plains are clayey. Deep, wide cracks form when the soils are dry.

Climate: The climate is Sudano-Sahelian and is characterized by a short season of rainfall and a longer dry season. The wet season extends from April to September, but 80 percent of the precipitation falls in July and August. The dry season lasts from late in September until early in June.

The weather is very hot from March to June and cooler from November to February.

The beginning of the rainy season in the northern part is characterized by severe windstorms that are followed by intense rainfall. The hazards of soil blowing and erosion are severe during these storms, which generally do not last long. As the rainy season progresses, the rains are more gentle and last longer.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Kousseri | 32 | --- | --- | --- | 18 | 21 | 80 | 150 | 205 | 79 | 5 | --- | --- | 558 |
| Waza | 60 | --- | --- | --- | 42 | 92 | 57 | 156 | 194 | 64 | --- | --- | --- | 605 |
| Maroua | 74 | --- | --- | --- | 22 | 102 | 45 | 124 | 332 | 133 | 74 | --- | --- | 832 |

Potential plant community and production: The potential plant community is characterized by Andropogon gayanus, Pennisetum pedicellatum, and Hyperrhenia rufa. The vegetation on the site is so depleted that it is difficult to determine the natural potential. Fenced study plots are necessary to evaluate fully the potential of this site.

The major species now on the site are Aristida adensions, Aristida stipoidies, Eragrostis tremula, Ctenium species, Pennisetum pedicellatum, Hyperrhenia rufa, and traces of Andropogon gayanus. Tree species are Combretum glutinosum, Seleracarya bierre, Anogeissus leiocarpus, Borassus aethiopum, Acacia seyal, Acacia senegal, and Acacia tortilis. Present productivity is less than 50 percent of the potential. Production ranges from 800 to 1,500 kilograms per hectare. The potential is 1,800 to 3,000 kilograms per hectare of perennial vegetation.

The site cannot be grazed when it is flooded or when the soil is saturated, because cattle would sink in the mud. It is grazed, however, as soon as livestock can walk on it. It is grazed by sheep and goats most of the year.

Forestry potential: Because the area is in the Sahelian Zone, forested areas are not used for industrial production. The cutting of trees for firewood and light building materials is the extent of the utilization of the forest. The present nursery in Kousseri is to be expanded to produce 500,000 plants a year and to maintain an adequate source of wood products.

Wildlife habitat: The potential for wildlife development is high. This site is in the western part of Parc National de Waza and is used by many types of wildlife.

Potential development for livestock industry: The potential for livestock development is medium because of severe flooding, lack of water supply during the grazing season, and difficulty in reestablishing the potential plant community.

Clay hardpan savannah--13

Location: Resource area F. This site is located mainly in the Parc National du Boubandjidah and the Reserve de Faoune du Faro.

Topography and elevation: Slopes on this site are gentle. Elevation ranges from 300 to 600 meters.

Soils: The soils are nearly level and clayey and are in lowlands. They have a shallow hard layer which restricts root growth.

Climate: The climate is Guineo-Sudanian and has two seasons. The season of rainfall lasts from early April to late October, but more than 80 percent of the total rainfall occurs in a 4-month period. In this period, more than 100 millimeters of rain falls each month. The dry season lasts from late October to early April.

The temperature is highest in February to June. It lowers when the rain begins and rises gradually in November.

| Station | Days of rain | Amount of rainfall in millimeters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| Tchollire | 75 | --- | --- | --- | 49 | 96 | 130 | 218 | 271 | 258 | 56 | --- | --- | 1,078 |
| Fignole | 78 | --- | --- | --- | 52 | 109 | 127 | 281 | 197 | 302 | 67 | --- | --- | 1,141 |

Potential plant community and production: The potential plant community is characteristic of a natural savannah. The dominant grasses are Hyperrhenia rufa, Andropogon gayanus, Panicum species, and Imperata species, and the dominant trees are Anogeissus leiocarpus, Terminalia sieberiana and Butyrospermum parkii. Annual production ranges from 1,500 kilograms per hectare in unfavorable years to 3,000 kilograms in favorable years.

Forestry potential: This site has medium potential for forest products. The shallow soils restrict tree growth.

Wildlife habitat: This site has medium potential for wildlife habitat. Large areas of this site are within the two national wildlife reserves, du Faro and Boubandjidah.

Potential development for livestock development: The potential for livestock development is medium. Forage production is not high because of the shallow clay soils. Insects and the difficulty of reestablishing the potential plant community are severe limitations.

## Limitations to development of the livestock industry

Table 29 gives the degree of the limitations on each range site to development of the livestock industry. The data are not intended to be used in rating the priority of different kinds of livestock development programs but to show the problems and potentials related to each range site.

Even though a grazing unit may consist of several range sites, each range site can be treated as a management unit.

The criteria used in determining the degree of the limitations are as follows:

I. Topography--Affects grazing distribution, utilization of vegetation, use of equipment, establishment of improved plant varieties, and development of water sources for livestock.

- No limitations--level to gently sloping.
- Slight limitations--rolling topography.
- Moderate limitations--gently sloping foot slopes and low hills.
- Severe limitations--long, smooth, steep slopes.
- Very severe limitations--very steep stony slopes on high mountains.

II. Flooding--Affects the length of time and the period when range can be used and the movement and management of livestock.

- No limitations--flooding and wetness of the soils is no problem.
- Slight limitations--water is occasionally on the surface for short periods.
- Moderate limitations--livestock grazing is not feasible during short periods of intermittent flooding.
- Severe limitations--long periods of flooding prevent grazing until the soil is dry.
- Very severe limitations--flooding lasts several months, sometimes killing vegetation and preventing use by livestock for much of the year.

III. Social--Population density and customs and habits of people.

- No limitations--thin population density, and people willing to accept new ideas and changes.
- Slight limitations--low population density, and people not willing to accept new ideas and changes.
- Moderate limitations--medium population density, and people willing to accept new ideas and changes.
- Severe limitations--medium population density, and people not willing to accept new ideas and changes.
- Very severe limitations--high population density, and people not willing to accept new ideas and changes.

Annual sorghum in the Yaere north of Waza.

Numerous volcanic peaks are on the fringes of the Adamaoua Plateau. This area, at the southern edge of North Cameroon, has high potential for livestock production.

A valley in the Rumsiki plateau.

Nomadic herdsmen leaving the Yaere Alluvial Plains (Resource area B) before rains begin. In the rainy season, the Logone River overflows its banks and floods a vast area that in the dry season is used by thousands of cattle in transit. Improved water supplies and control of grazing are needed in this area.

Livestock grazing on sodium-affected soils on the Diamare plains north of Mora.

TABLE 29.--Limitations to development of livestock industry, by range site

[Criteria for rating the limitations are explained in the text]

| Range site and number | Limitations imposed by-- | | | | | Social limitations |
|---|---|---|---|---|---|---|
| | Topography | Flooding | Livestock water | Disease and insects | Reestablishment of the potential plant community | |
| Sandy Open Savannah--1A | None | Slight | Moderate | Slight | Severe | Severe. |
| Sodic--1B | None | Severe | Severe | Moderate | Very severe | Severe. |
| Flood Plain--2 | None | Very severe | Severe | Moderate | Slight | Slight. |
| Stony Loamy Savannah--3A | Severe | None | Moderate | Moderate | Moderate | Moderate. |
| Red Ferruginous Savannah--3B | Slight | Slight | Moderate | Severe | Moderate | None. |
| Deep Loamy Savannah--4 | None | Slight | Moderate | Severe | Slight | None. |
| Meadow--5 | None | Severe | None | Severe | Slight | None. |
| River Bottom--6 | None | Very severe | None | Severe | Slight | Slight. |
| Alluvial Granite Savannah--7 | Slight | None | Moderate | Moderate | Severe | Slight. |
| Shallow Rocky Slopes--8A | Severe | None | Moderate | Slight | Very severe | Very severe. |
| Upland Plateau--8B | Slight | None | Moderate | Slight | Slight | Slight. |
| Steep Mountain Savannah--9 | Very severe | None | Slight | Very severe | Very severe | None. |
| Sandy Dense Savannah--10 | None | None | Slight | Moderate | Moderate | Slight. |
| High Plateau--11 | None | None | Slight | Moderate | None | None. |
| Clayey Savannah--12 | None | Severe | Moderate | Moderate | Moderate | Moderate. |
| Clay Hardpan Savannah--13 | None | Slight | Moderate | Severe | Severe | None. |

IV. Livestock water--Affects the utilization of vegetation and livestock health and reproduction.

No limitations--an adequate supply of good quality water exists for the entire grazing period.
Slight limitations--an adequate supply of poor quality water exists for the entire grazing period.
Moderate limitations--a dependable supply of good quality water exists but is not regularly available.
Severe limitations--the water supply is not dependable, and long distances separate sources of good quality water.
Very severe limitations--no dependable source of water, and long distances separate sources of poor quality water.

V. Insects and diseases--Affect the distribution of grazing and the health and management of livestock.

No limitations--the area is clear of insects and diseases.
Slight limitations--insects are a nuisance but are not detrimental to animal health; diseases are not a problem.
Moderate limitations--a continuous program of vaccination and dipping is required to maintain health of livestock.
Severe limitations--the tsetse fly and animal diseases need to be controlled continuously for yearlong grazing.
Very severe limitations--grazing is limited to the dry season because of the difficulty and cost of controlling the tsetse fly.

VI. Reestablishment of the potential plant community--Dependent on the history of land use, for example, abandoned farm land; range that is now in annuals; invasion by undesirable plants; and severe erosion that is caused by a lack of plant cover throughout most of the year. See the section "Scope of Range" for an explanation of the terms describing condition of range.

No limitations--range is in good to excellent condition.
Slight limitations--range is in fair to good condition, and a high percentage of potential plant species remains.
Moderate limitations--range is in fair condition and has a good ground cover; less than 50 percent of the potential species remains. Erosion is evident.
Severe limitations--range is in poor condition. Vegetation is mostly annuals. Erosion is severe at beginning of wet season and continues until annuals protect the soil. There are no soil or site limitations for revegetating. Reseeding generally is necessary.
Very severe limitations--bare soils are subject to yearlong soil blowing and erosion. The site is difficult to reseed because of slope and other soil characteristics. It has areas of dense brush that is costly and difficult to control.

## Range management concepts

The basic range management goal is to increase animal production while protecting the soil, water, plants, and wildlife. Good range management programs are difficult to develop in North Cameroon because 1) social customs are long-standing, 2) the lack of forage and water during the long dry season requires that animals be moved frequently, and 3) rights to graze rangeland are based on custom and the history of use. The government has the right to arbitrate actual use.

Development of a good range management program requires controlling the resources of land, water, and vegetation. This control can be achieved by range management programs that are either developed and administered by the government or involve the residents or users of land.

The location and size of management areas can be determined on the basis of need and available resources. Boundaries of management areas can be marked, cleared, and used for fire lanes. The cost of constructing and maintaining fencing is high, and fences should not be constructed until construction is economically feasible.

Wells or ponds should be developed for livestock water. They should be spaced at intervals of 3 to 6 kilometers, or less, in areas where livestock movement is not difficult and water development costs are low. Wells and ponds should be spaced 1 to 3 kilometers apart in intensively managed areas. Farming near wells must be restricted. (See section "Establishing Grazing Reserves.") The initial stocking rates of the range must be determined prior to development of management areas. Initial stocking rates can be determined by a detailed inventory made for this purpose or by information from actual use where it is available.

A range-use survey can be estimated by observing the effects of grazing on a key plant species. A key plant species is generally the dominant species. It is the most abundant and most palatable of the plants, and it generally produces the most forage. If observation of the effects of grazing on a key species over a period of years shows that it is decreasing in abundance and vigor, adjustments must be made in livestock numbers or in the grazing system.

In planning a grazing system, the length of the grazing season and the amount of forage that can be grazed without adverse affect on the plant must be considered.

Only one-half (by weight) of the aboveground part of grass plants should be grazed. The other half must be left to maintain the plant in good health and to protect and maintain the soil resources.

A good grazing system includes resting one-fourth to one-third of the range during the growing season. Resting allows the key plants to recover from past grazing use, produce a seed crop, and reseed. The result is an improvement in the composition and density of the grass cover.

## Use of fire

Most rangeland is burned annually to eliminate pests such as ticks and snakes, to get rid of unused dry grass, and to keep bush species out of the grasslands. Uncontrolled burning, however, destroys forage needed for dry-season grazing. Fires can be caused by hunters and beekeepers and by farmers burning crop residue and weeds. Annual burning creates a fire-tolerant cover of grass and trees, but the fire-tolerant grasses are not the most palatable and nutritious to livestock.

Burning is an effective range management tool if done properly. Controlled burning for brush control should generally be done every 3 to 5 years at the end of the dry season. Resting the range before and after fire treatment is recommended. Grass growth is so rapid after a burn, however, that grazing at a moderate stocking rate 4 to 6 weeks after burning has no detrimental effect on forage growth and reproduction.

## Wet- and dry-season grazing

There are very few areas in North Cameroon that can be grazed only in the wet season. Areas of sandy or cobbly soils are preferred for grazing during the wet season, and they are also grazed year long. Local and migrant cattle herds graze the range as it begins to grow, and sheep and goats graze the area throughout the year. By the end of the dry season, goats generally stand on their hind legs to eat the vegetation in trees and shrubs that remains within their reach.

Dry-season range cannot be grazed during the wet season. For example, the yaeres cannot be grazed during the wet season because of the flooding hazard and clayey soils. The South Benoue cannot be grazed during the wet season because of the tsetse flies.

## Land of great contrasts

There is a sharp contrast between the dry season and the wet season in North Cameroon. At the end of May the Logone-Chari Delta, Diamare Plains, and Mandara Highlands resource areas are barren. The only vegetation is along waterways or in places where underground water is within the root zone of the deep-rooted trees and shrubs. At the beginning of the rainy season the brown, barren areas begin to revegetate, and within a few weeks annual vegetation is 1 to 2 meters high.

Because of the extremes in climate, perennial vegetation must have a deep root system to use moisture stored deep in the soil, or the vegetation must consist of annuals that can germinate and develop mature seed during a short wet season.

## The value of range management

Where cattle are raised for profit, the value of grazing land in any one year is directly related to the amount of meat that is produced during the year. If the range is maintained in excellent condition and is well managed, the present value and potential value of the land are about equal. Under very poor management and with the range in poor condition, only a fraction of the gain is attained and the present value is proportionately lower than the potential value.

Figure 8 illustrates the relationship of stocking rates and range condition to kilograms of animal growth per hectare. Figures in the graph are estimates and should be verified by field studies. The broken lines of example A indicate that 75 kilograms of animal growth per hectare are produced by 6 animals in 1 month on the Sandy Open Savannah range site when it is in excellent condition. Example B indicates that 6 kilograms of animal growth are produced by 1 animal in 1 month on 3 hectares of range in poor condition, or 1 hectare produces 2 kilograms of animal growth. Thus, the ratio between the production of range in excellent condition and poor condition is 75:2 or 37.5 to 1. Note that in example B, 0.3 means that this is approximately 1/3 of an animal unit, or 1 animal unit requires 3 hectares. From these figures it can be seen that if 1 kilogram of live animal weight is valued at 100 FCFA, the relative values of the animal growth will be 7,500 FCFA compared with 200 FCFA.

Figure 8 applies only to the Sandy Open Savannah range site. The relationships differ for each range site.

The amount of grazable forage produced determines the number of animals that can be grazed. In table 30, the kilograms per hectare of grazable air-dry forage is used as a guide to determine the number of animal units that can be grazed on 1 hectare for 1 month and the number of hectares required to graze 1 animal unit for a given number of months. If the grazing period differs from those for which initial stocking rates have been computed, it is necessary to calculate the initial stocking rate by arithmetical means. For example, to calculate the initial stocking rate for a 5-month period of grazing, add the figures shown for 4 and 6 months and divide by 2.

The rate of animal-weight gain during the period of grazing is directly related to the growing period of the grazed plants. Figure 9 shows the rate of animal-weight gain in kilograms over a 12-month period on rotation pasture at Wakwa. In the Wakwa study, animal weight per hectare increased from 500 kilograms at the beginning of the wet season to 691.5 kilograms at the end of the wet season. When the grasses matured, however, the animals lost weight. The animals lost 5 percent of their body weight from the end of the wet season to the end of the dry season. The gain in animal weight per hectare was only 157 kilograms over the 12-month period.

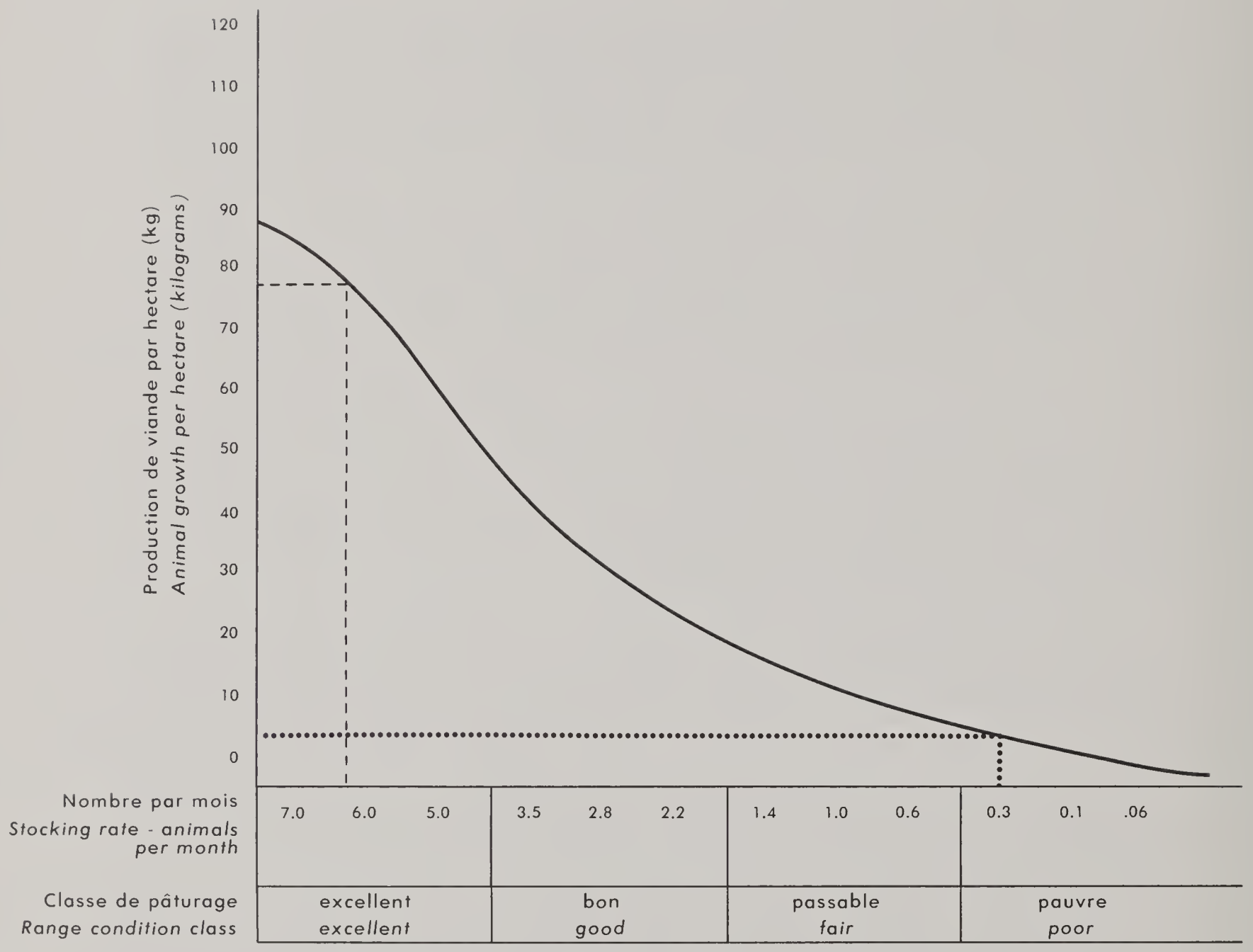



Figure 8 - Production de viande par rapport au nombre de têtes de bétail et aux classes de pâturages dans le Savane découverte et sablonneuse

*Beef production in relation to stocking rates and range condition in the Sandy Open Savannah range site*

TABLE 30.--Initial stocking rates where the yield of grazable air-dry forage is known

| Air-dry forage in kilograms that can be properly grazed on 1 hectare | Animal units[1/] that can graze 1 hectare for 1 month | Hectares required to graze one animal unit for-- | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 mo. | 4 mo. | 6 mo. | 8 mo. | 10 mo. | 12 mo. |
| 25 | 0.06 | 17.00 | 68.0 | 102.0 | 136.0 | 170.0 | 204.0 |
| 50 | .10 | 10.00 | 40.0 | 60.0 | 80.0 | 100.0 | 120.0 |
| 100 | .30 | 3.00 | 12.0 | 18.0 | 24.0 | 30.0 | 36.0 |
| 200 | .60 | 1.50 | 6.0 | 9.0 | 12.0 | 15.0 | 18.0 |
| 362 | 1.00 | 1.00 | 4.0 | 6.0 | 8.0 | 10.0 | 12.0 |
| 500 | 1.40 | .70 | 2.8 | 4.2 | 5.6 | 7.0 | 8.4 |
| 650 | 1.80 | .60 | 2.4 | 3.6 | 4.8 | 6.0 | 7.2 |
| 800 | 2.20 | .50 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 |
| 1,000 | 2.80 | .40 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 |
| 1,250 | 3.50 | .30 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 |
| 1,500 | 4.10 | .24 | 1.0 | 1.4 | 1.9 | 2.4 | 2.9 |
| 1,750 | 5.00 | .20 | .8 | 1.2 | 1.6 | 2.0 | 2.4 |
| 2,000 | 6.00 | .17 | .7 | 1.0 | 1.4 | 1.7 | 2.0 |
| 2,500 | 7.00 | .14 | .6 | .8 | 1.1 | 1.4 | 1.7 |
| 3,000 | 8.00 | .12 | .5 | .7 | 1.0 | 1.2 | 1.4 |
| 3,500 | 10.00 | .10 | .4 | .6 | .8 | 1.0 | 1.2 |
| 4,000 | 11.00 | .09 | .4 | .5 | .7 | .9 | 1.0 |
| 4,500 | 12.00 | .08 | .3 | .5 | .6 | .8 | .9 |

TABLE 30.--North Cameroon--Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5,000 | 14.00 | .07 | .3 | .4 | .6 | .7 | .8 |
| 5,500 | 15.00 | .06 | .2 | .4 | .5 | .6 | .7 |
| 6,000 | 17.00 | .05 | .2 | .3 | .4 | .5 | .6 |

1/ One animal unit represents one mature cow, seven sheep or goats, one horse or one donkey; 362 kilograms of air-dry forage is required to feed 1 animal unit for 1 month.

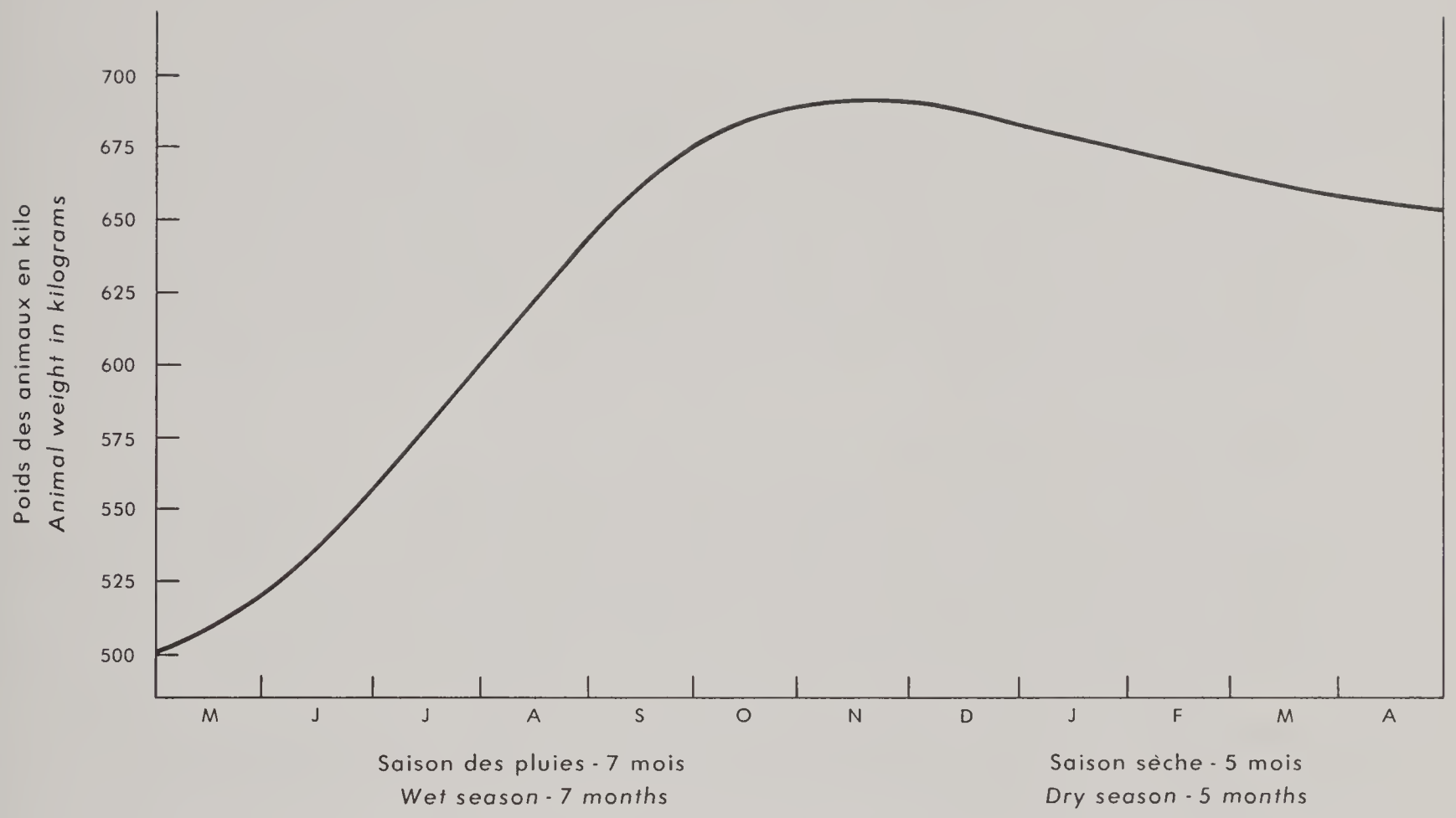



Figure 9 - Taux de gain ou perte de poids des animaux suivant les saisons

*Rate of gain or loss of animal weight by seasons*

Animals gain weight rapidly during the wet season because of the higher protein content of the vegetation. Figure 10 shows the protein content of perennial grasses in North Cameroon over a 12-month period. Only in the wet season, which is the period of plant growth, does the protein content rise above the maintenance requirements of the animal. According to the data contained in figure 10, the protein content of the grasses is considerably lower than the daily need of the animals during the dry season. Protein supplements or use of irrigated pasture is needed to continue weight gains during the dry season.

Other values of vegetation

Plants are of use to the soil in a number of ways. Each plant acts as a small dam. It holds water in the immediate area so that more moisture penetrates the soil. Plant roots make channels in the soil, making the soil more porous and allowing faster water penetration. The decaying leaves and roots of plants increase the fertility of the soil and improve its tilth and structure. Plants also keep the soil cooler, thereby lessening evaporation.

Plants are used as food cover by game animals. In addition, lions and other large predators are found only where forage for game animals is adequate.

Plants also have recreational value and enhance the scenic beauty of woodland and range areas.

## Plant and soil development

The interaction of soil and natural vegetation produces a unique potential plant community. This potential plant community is influenced by climate and by other factors, for example, microorganisms, insects, grazing animals, and fire. Other changes occur in the potential plant community when it is misused by man. Plants in turn influence soil development. The decaying roots and leaves provide organic matter to enrich the soil.

Plants make their own food

Plants manufacture their own food for growth. This manufacturing of food takes place in the green leaf where energy is converted from sunlight by photosynthesis to begin the food energy chain that nourishes all life. No single chemical reaction is as important to our existence as is photosynthesis.

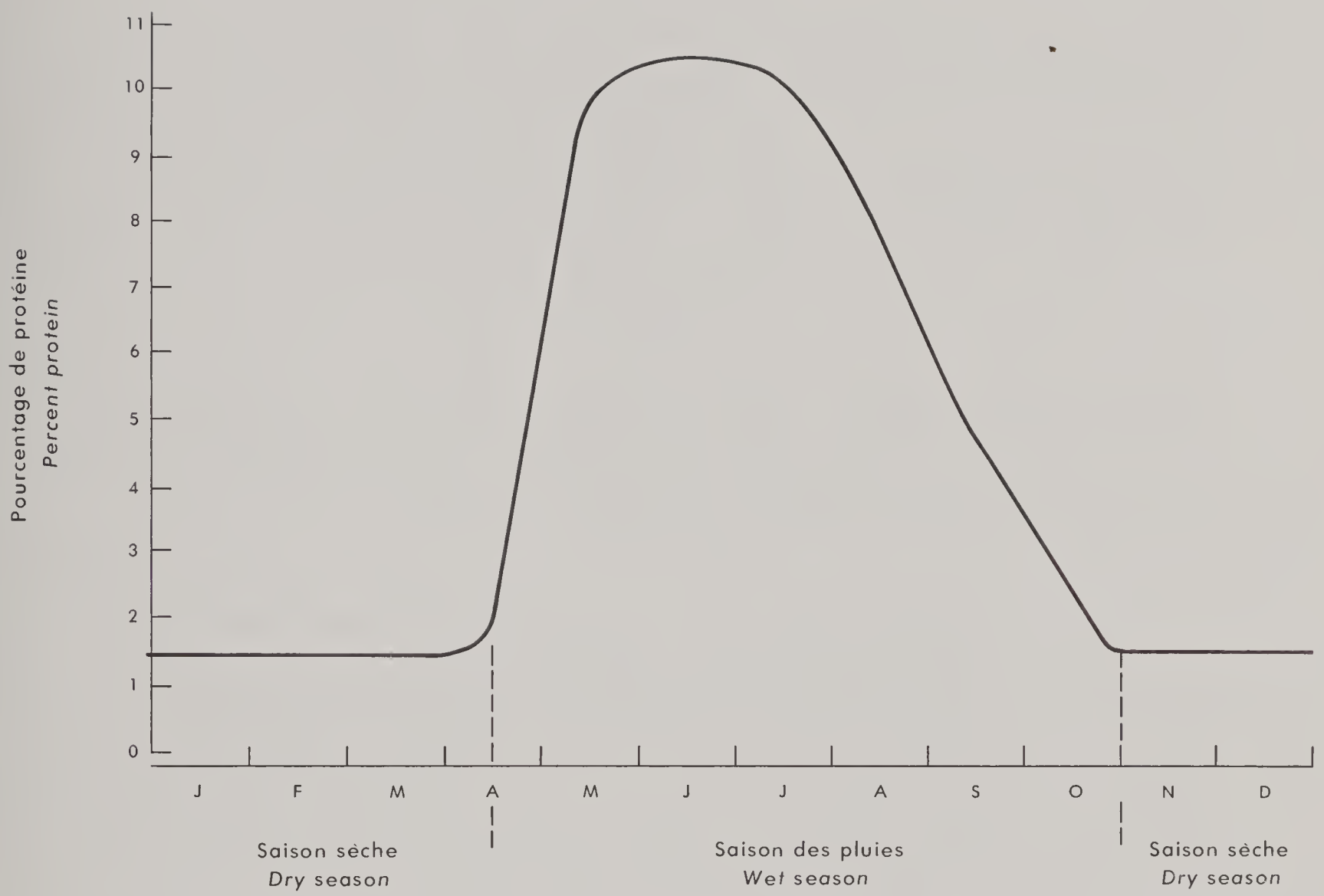



Figure 10 - Teneur estimée en protéines des herbes vivaces pendant l'année

*Estimated protein content of perennial grasses during a 12-month grazing period*

The plant draws water and nutrients from the soil through its roots and transports it to leaf cells. Carbon dioxide is absorbed from the air through tiny pores on the lower side of the leaves. In the leaves, a series of chemical reactions combine carbon, hydrogen, and oxygen into simple sugar. The sunlight combines with other elements to form proteins, carbohydrates, fats, and plant oils. The plant uses these elements to build new tissues that become grain, a direct source of food for man, or that are eaten by livestock and converted to milk or meat.

The plant is weakened if this food manufacturing process is disrupted by heavy grazing, fire, drought, insects, or disease. If grazing pressure continues so that the weakened plant cannot manufacture sufficient food to replenish its reserves, it eventually dies. Plants that are not grazed replace the better forage plants. If heavy grazing continues, the less palatable perennial plants also die. They are replaced by annuals, unusable plants, or even poisonous ones. With continuous burning and other abuses, soil erosion eventually makes the soil barren and sterile.

## Grazing systems

A grazing system, simply stated, is a plan that indicates when and where livestock are to graze, and the proper use of any grazing system is the first step toward efficient range management. A planned system that considers the needs of plants will maintain plant vigor. In a planned system range can be grazed without damaging the better forage plants. In fact, grazing at the proper season and level of use rapidly improves the plant community. Healthy range forage plants produce more food, leaves, and seeds than they need to maintain and reproduce themselves. This surplus can be grazed by animals without harm to the forage stand.

To minimize damage to plants, grazing should be light to avoid damage to forage plants, and range should be rested periodically to permit grazed plants to regain vigor and produce seed and to allow new seedlings to become established. Continuous grazing generally creates distribution problems. To achieve a proper degree of use on continuously grazed range, animal numbers must be controlled. Some parts of an unmanaged range may be overgrazed while other parts are not grazed heavily enough. Planned grazing systems make more efficient use of the total forage crop.

### Benefits of grazing systems

The objective of a grazing system is to improve the range resources. This objective can be achieved by better utilization of all plants. It enables greater efficiency in the harvesting of forage and permits the grazing of more animals in a given area.

Besides allowing forage plants time to recover so that they can increase in density and production, other results of a successful grazing system include decreased sheet and gully erosion, improved wildlife habitat, increased animal production, and lower animal-handling costs. Successful grazing systems allow for proper root growth, top growth, food storage, and reproduction of plants. They also provide adequate nutrition for grazing animals. Range seeding and burning, shrub control, water development, and other management practices improve the effectiveness of a grazing system but are not a part of the system itself.

No single grazing system is suited to all rangeland. The primary concern in selecting a system is insuring that rest periods are properly timed and are long enough and frequent enough to allow key forage plants to recover after each burning and grazing period.

## Woodland

Trees make up the climax vegetation in some areas of North Cameroon, especially along streams. Grazing management systems for woodland are similar to those for open rangeland and savannahs.

Shade-tolerant plants grow beneath a dense tree canopy and need little sunlight. If a woodland site is destroyed by burning or clearing, the shade-tolerant plants cannot survive and are replaced by plants that grow well in direct sunlight. Continued misuse of the plants that grow well in direct sunlight kills them, and only annual vegetation remains.

After a woodland plant community has been destroyed by fire or clearing, and if the base soil property has not been changed or degraded, the site still has potential for use as woodland. Under good management, trees again dominate the site, the canopy thickens, and only shade-tolerant plants survive in the understory. Grazing of the understory should be managed to allow the most nutritious forage plants to remain. Regardless of grazing management, the more dense the tree canopy, the less dense the understory. Therefore, the grazing value of the understory is less if the tree canopy is dense.

In most woodland plant communities, the value of woodland for livestock grazing is secondary to its value as a source of firewood, building material, medicines, and food and as a suitable site for wildlife habitat.

## Depleted land

Many areas in the Logone-Chari Delta and Diamare Plains resource areas are nearly barren because of extreme grazing pressures, frequent fires, and poor cultivation practices. Even annual plants do not grow well in some places.

Acacia species now dominate many of the sites. The domination of these areas by acacia is a natural adaptive measure which restores soil-protecting vegetation and adds nitrogen and organic matter to the soil. The thorny protection and unpalatability of the acacia keep grazing animals away and allow acacia to establish itself and spread quickly into areas unoccupied by other plants. Acacia is fire resistant and spreads by rootstocks. The ground underneath the acacia is generally free of flammable plants.

To restore grazing use of the area, grazing should be deferred until annuals and perennial grasses can become established. Acacia can then be controlled by burning the site and hand clearing the acacia. When perennial grasses are reestablished, they compete with the acacia and help to control it.

## Establishing grazing reserves

A continuous struggle exists between livestock producers and the crop farmers. Livestock graze on cropped fields that lack barriers. Though the herds and flocks are carefully guarded, they continue to invade and graze in cultivated areas. One solution to this problem is to establish grazing reserves throughout North Cameroon. These areas would operate under a grazing management plan. Many years of planning and progressive development will be needed. It would be advisable to start with a few selected areas. The Logone-Chari Delta and Diamare Plains resource areas are badly denuded and are possible locations for study areas. Grazing management is needed to reestablish vegetation and control erosion in these resource areas.

The northern division of the office of livestock has proposed the establishment of grazing reserves or ranches and has drawn a map of the proposed locations. A copy of this map is included in their report.

There are two approaches possible for development of grazing reserves or ranches. The Government can select the area, plan the development, install necessary improvements, purchase equipment, stock the reserve with livestock, and oversee the entire operation; or it can give professional help to tribal groups in developing and managing their grazing reserves.

The latter approach offers the most promise. Reserving the necessary land for ranches will be easier if the ranches are organized among tribal groups and if tribal leaders are cooperative and interested. Development costs for such ranches are lower, because the tribe or group can police its own boundaries. Also, there is more interest in controlling fires. Important forage resources now being consumed by range fire can be saved by enlisting the aid of tribal leaders. Furthermore, labor costs are reduced, and no special marketing arrangements are required. Tribal members can market their animals through usual market channels. Besides being more economical to establish than Government-operated ranches, tribal-operated ranches will encourage tribal unity. Family groups and tribal leaders can work together to improve their standards rather than have an outside supervisory structure imposed on them. Tribal-operated ranches encourage the fullest use of a country's resources--people, herds, land, and water. And they can be expanded with relatively few social and economic disturbances.

Professional assistance to tribal-operated ranches, especially in range management and disease control, would be supplied by the Government of Cameroon. The Government would work to educate livestock owners and to develop among them an awareness of the benefits of sound range and herd management. The Government would pay for construction of stockwater wells or ponds. On the other hand, it would be the responsibility of the tribes to police the ranch boundaries, enforce the grazing plans, and market the livestock.

An essential part of this plan is the selection of a homogenous tribal group with recognized leaders who are willing to associate themselves with a plan to manage their traditional grazing lands.

Ranch size depends on the nature of the tribal groups, the extent of their respected leadership, the productive capacity of the rangeland, and to some extent, the topography.

Some large ranching enterprises undertaken in other African countries have failed. It is advisable, therefore, to start with a small operation, and as the program becomes successful, the operation can be enlarged. Problems which evolve in a new enterprise can be more readily and successfully resolved for a small operation than for a large one.

Managing grazing to leave forage on the range for use during the dry season requires limiting the number of grazing animals. Because this is contrary to tribal tradition, at first it may be necessary to include on the grazing reserve all animals owned by the tribal groups. Professional assistance and advice should stress the economic advantages of eliminating older, barren, or less desirable animals. In this way, herd numbers would eventually balance with the productive capacity of the range.

Whichever approach is used, it is essential to carefully evaluate all the resources and develop a simple but complete management plan. Each plan should fully consider the needs of the plants.

## Consideration of range improvement programs

It is more economical to develop a livestock program on rangeland that is in good or excellent condition than on that which is in poor or fair condition. The range in better condition yields higher returns on monetary investments and presents fewer problems. Rangeland can be developed at minimal expense by eliminating the tsetse fly and the problems associated with traditional land use.

Consideration should also be given, however, to the need for elevating the standard of living for inhabitants in the more densely populated portions of the northern part of North Cameroon. Here, soil erosion is a major problem, and unless it can be controlled many agricultural and grazing areas will become sterile and unproductive. The Logone-Chari Delta, Diamare Plains Highlands, and Mandara Highlands resource areas are examples. Range improvement programs should have long-range goals. Time, money, and labor are needed to reverse the deterioration of the basic land resources. The benefits may not be realized for many years, but the need to begin a range improvement program is great, even if on a small scale.

## Proposed grazing reserves

There are 320 proposed grazing reserves. They vary in size from a few hundred to more than 300,000 hectares. (See the section "Establishing Grazing Reserves.") A few selected areas can be used as pilot grazing reserves to be evaluated before continuing on a large scale plan.

## Range demonstration plots

At least one range demonstration plot should be established in each major land resource area to help solve various range problems. The station at Louggere is an excellent place to establish demonstration plots. It can also be used as a control headquarters for continued evaluation of grazing management design. Some subjects for evaluation are:

1. The response of areas in various range sites and condition classes that are not grazed for 2 or 3 years and are then used for managed grazing.
2. The identification of species that are well adapted for seeding of depleted range for range forage.
3. Determination of the most economical methods of seeding and weed control.
4. Measuring the nutritive value of vegetative species in various seasons of the year.

## Livestock water development

Many areas need a permanent livestock water source before detailed grazing management systems can be developed. Livestock watering facilities can be developed by making ponds, drilling or digging wells, or constructing pipelines and troughs from existing sources of water. An onsite evaluation must be made to determine the most dependable source of water and the most economical facility that can be developed.

The Yaere flood plain is probably the most productive and most heavily grazed natural grassland in central Africa. Most of the natural vegetation has been conserved because of the climatic conditions and location. The natural flooding of the Logone River during the wet season prohibits grazing for at least 4 or 5 months each year. This enables plants to grow and to maintain vigor before grazing begins. When the Yaere becomes dry enough to be grazed, much of the area cannot be utilized for a long period because of the lack of water for livestock. Areas that are close to water are damaged from continual burning.

To fully utilize the 240,000 hectares of the Yaere flood plain, a resource conservation grazing plan should be developed by subsections or by small management units. A detailed resource inventory should be made to determine the underutilized and overutilized areas, grazing capacity, and areas for water development. A planned system is needed to control livestock numbers and time and place of grazing and to rotate grazing with resting and burning. To prevent misuse or further deterioration of the natural resources, water sources should not be developed until a grazing plan has been adopted.

Livestock development program for the South Benoue

Several proposed grazing reserves are immediately south of the Benoue River and Garoua, and others are in resource areas F, G, H, and I. Priority for planning should be in the areas south of Garoua and closest to the river and along the east side of the river below Lagdo. The reasons for giving priority to these areas are listed below.

1. These areas are easily accessible.
2. The tsetse fly should be easier to control than elsewhere because there is a control zone to the north.
3. The local inhabitants are in favor of the project.
4. The range is in fair to good condition and can provide adequate livestock forage.
5. Supplemental feed, for example, cottonseed cake and peanut meal, can be used during the dry season.
6. The areas have good potential for irrigated pastures adjacent to the grazing area.
7. Good highways close to the rail terminal at Ngaoundere provide easy transport to markets.
8. Crop residue along the Benoue River can be included in the grazing system.
9. Some of the herd can be finished in a feedlot or finished on a pasture with concentrates.

During the wet season the cattle can be expected to gain 0.4 kilograms per head per day. (See table 30 and figures 8, 9, and 10.) If they are fed a supplement of 0.7 kilograms of undelinted cottonseed per head per day while they graze in the dry season, the cattle can be expected to gain 0.2 kilograms per day. A similar gain can be made if pastures of stylosanthes or other adapted legumes are planted to supplement dry-season grazing. Stylosanthes has 9 to 10 percent content of crude protein in January. It produces 4 to 6 tons of air-dry forage or hay per hectare after establishment in pure stands on dry pasture and 10 to 12 tons per hectare in irrigated pasture.

Estimated production of these proposed grazing areas is 800 to 1,200 kilograms of usable air-dry forage per hectare. The initial stocking rate is 4 to 6 hectares per animal unit for 12 months (table 30). A 50,000 hectare unit can possibly support 10,000 head of cattle. Until a grazing plan has proved to be effective, however, half this number is more reasonable. Cattle growth rates in the South Benoue are generally limited by the quality of the feed, not by the quantity.

Range seeding project

Many large areas in resource areas A, B, C, and D can benefit greatly from a range seeding program. Such a program should proceed slowly. Grazing must be controlled before the range can be seeded. Trials should be made to determine the species that are best adapted to the various sites. Finally, the best and most economical method of seeding should be determined before a large-scale project is begun.

Program for training Cameroonian range conservationists

A good grazing management program can be applied to more than 7,000,000 hectares of rangeland in North Cameroon. This figure excludes cropland, lakes and streams, woodland, roads, municipalities, wildlife reserves, and miscellaneous areas unsuitable for grazing. Plans should be made for training range conservationists by--

1. Sending qualified personnel to countries that have range management schools and on-location training programs.
2. Establishing management courses in the local university system.
3. Establishing training locations in North Cameroon staffed by qualified range management instructors from other countries.
4. Introducing range management courses at centers for training farm families or at other training centers.

## Problems of livestock enterprise and range management

The major problems of livestock enterprise and range management are as follows:

1. There is a conflict between the producers of livestock and the producers of crops. Discord occurs in areas where livestock that are not carefully herded damage cultivated crops. In addition, during the heavy fly season, animals are grazed at night; they enter cultivated fields and eat crops.
2. Migratory herds from Chad and Nigeria are difficult to control. They roam freely, and the times and places that they graze are not restricted.
3. The political structure in many regions makes controlled grazing difficult. The Sultan and village chiefs in various regions levy a tax on transit herds. Therefore, if transit grazing were prohibited, funds to the local treasury would be greatly reduced.
4. Although North Cameroon has a good livestock health program, programs to improve forage on native rangeland are minimal.
5. There are no professional Cameroonian range management specialists. Only a few range technicians understand the principles of range management.

6. Insects, particularly the tsetse fly, restrict grazing in some areas.
7. Lack of a permanent water supply makes it difficult to distribute grazing and to plan grazing management programs.

## Economic returns from irrigated pasture and forage crops

Until 1973, economic returns from well-managed irrigated pasture favorably competed with those from food crops. Most food crops then doubled in price, but the price of cattle remained the same. For example, in a 2-year period in the United States the price of wheat, dried beans, sugar, and potatoes doubled or tripled. In the same period, the price of cattle dropped from 70 cents per pound (300 FCFA per kilo) to 35 cents per pound (150 FCFA per kilo). Many farmers can net $500 per acre (220,000 FCFA per hectare) from food crops. The best price netted from irrigated pasture, however, is $250 per acre (110,000 FCFA per hectare).

Besides the comparatively low economic returns, the use of irrigated pasture for livestock production is an inefficient use of energy, especially because of the world food shortage. Livestock convert only about 20 percent of the nutrient energy present in forage and grain. About 80 percent, therefore, of the total nutrient energy in forage and grain is lost.

Still, the productive use of irrigated pasture can be achieved through the rotation of grass and legume pastures with food crops. Pasture is a soil-building land use, whereas food crops generally are soil-depleting. The last growth of pasture can be plowed into the soil to add mulch and humus.

Many soils are best suited to a permanent plant cover. Easily eroded, steep soils and soils that are too wet for some food crops or are too high in mineral content generally are best suited to pasture.

Another productive use of pasture is the grazing of short-term annuals. Because of the 12-month growing season in North Cameroon, annual pasture can be planted after a food crop is harvested to supply a source of green feed when the native range is dry and the plants are low in protein. Plowing pasture residue into the soil also adds fertility and organic matter to the soil, thus maintaining soil productivity for food crops.

Irrigated pasture can also be used to produce grain or hay for cattle that are being finished for market. An animal generally can be finished in 90 to 100 days by being fed forage and supplementary grain or oilseed meal. An animal fed in this manner yields meat that is higher in quality than that now shipped to coastal markets.

In summary, development of irrigated forage is expensive and difficult to justify from an economic standpoint. The development of irrigated pasture can be a very practical investment, however, if the pasture is used in rotation with food crops or as short-term pasture or is used to maintain animal-weight gains during the dry season.

Social and Economic Considerations

This section discusses cattle-raising practices among the different peoples in the survey area, land ownership and inheritance, and the amount of land available for grazing and other uses. Some conclusions on the land system are also given.

## Cattle raising among the different peoples

### Islamic people

Of the Islamic groups, the Foulbe, Mbororo, and Arab-Choa raise cattle. These make up 70 percent of the population.

The Arab-Choa live in the Serbewel area. They move their cattle from pasture to pasture in search of grass in the Lake Chad and Yaere areas. They do only a small amount of farming.

The Mbororo people are nomadic Foulbes. They raise only cattle and travel long distances to find pastures for their cattle. Many pass through the Benoue in the dry season in their migration from Nigeria to the Central African Republic. Others pass through the Yaere when travelling from Chad to Nigeria.

The Foulbe is the largest tribe in North Cameroon. This tribe has provided North Cameroon with its customs, code of law, and religion. The Foulbe were formerly nomadic herdsmen who settled in this area in the 19th century. Ownership of cattle remains a symbol of rank and prestige with the Foulbe.

### Mountain people

The Mountain people are excellent farmers. In addition, all of them raise some livestock, mostly sheep and goats and a few cattle.

Because the population density is high, cattle are raised in pens. The cattle are kept in pens for 2 or 3 years, depending on the tribal custom, and then sacrificed at the feast of Maray. The Mountain people provide food for the penned animals during the long dry season, which lasts from October to April.

### Highland people

Of the Highland people, only the Kapsiki and Goude tribes raise cattle. Although the other Highland people do not raise cattle, each household has sheep, goats, and fowl. Local dignitaries and officials often own cattle, but Foulbe herdsmen care for them.

### Plains people

The Massa and Toupouri are the only tribes among the Plains people who raise cattle. Cattle are grazed on uncultivated village land during the day and returned to their owner's compound each night. Cattle are important in the social life of the tribes.

### South Benoue people

Among the South Benoue people only the Doayo, who live in the Poli area, raise cattle. The cattle are allowed to roam freely. The area around the household is reserved for the livestock and is uncultivated. Fields for crops are located at a distance from the villages.

## Land ownership and inheritance

In most tribes, land is owned collectively by the tribe or the inhabitants of the village. Individuals, however, build their houses, cultivate their crops, and graze their animals. Land ownership varies because each tribe has developed its own system of ownership. The principles of land ownership, nevertheless, remain the same.

In a few tribes, land is owned by the individual. But generally an individual has only the right of use rather than the right of ownership. He is seldom deprived of land use. The right to use the land is gained by clearing the land, by inheritance, and by renting.

Inheritance of ownership or right of use generally passes from the father to the oldest son. Only in the Foulbe tribe are women included in the inheritance. Distribution of the inheritance among the male members of the family can vary. Many tribes require the oldest son to divide land with his brothers, and others require that goods other than land be divided equally among all children.

The customs regarding acquisition and administration of land rights are summarized in table 31. The customs relating to methods of inheritance are summarized in table 32.

TABLE 31.--Summary of customs relating to acquiring and administering landrights

| Tribe | Ownership | Acquisition of land by-- | | | | Administrator |
|---|---|---|---|---|---|---|
| | | Inheritance | Clearing | Purchase | Rent or loan | |
| Toupouri | Tribe | Yes | Yes | Yes | Yes | Individual. |
| Massa | Tribe | Yes | Yes | Yes | Yes | Individual. |
| Guiziga | Tribe | Yes | Yes | Yes | Yes | Chief. |
| Mandara | Tribe | Yes | Yes | No | Yes | Individual. |
| Kotoko | Tribe | Yes | Yes | Yes | Yes | Sultan. |
| Foulbe | Individual | Yes | No | Yes | Yes | Individual. |
| Mafa | Individual | Yes | No | Yes | Yes | Individual. |
| Ouldeme | Individual | Yes | No | Yes | Yes | Individual. |
| Mafou | Tribe | Yes | No | No | Yes | Chief. |
| Guidar | Tribe | Yes | Yes | No | Yes | Chief. |
| Fali | Tribe | Yes | Yes | No | Yes | Chief. |
| Tchevi | Tribe | Yes | Yes | No | Yes | Chief. |
| Djimi | Tribe | Yes | Yes | No | Yes | Chief. |
| Bana | Individual | Yes | Yes | Yes | Yes | Individual. |
| Kapsiki | Tribe | Yes | No | No | Yes | Individual. |
| Pape | Tribe | Yes | Yes | No | Yes | Individual. |
| Doayo | Tribe | Yes | Yes | No | Yes | Individual. |
| Bata | Tribe | Yes | Yes | No | Yes | Individual. |
| Tchamba | Tribe | Yes | Yes | No | Yes | Individual. |
| Koma Kadam | Tribe | Yes | Yes | No | Yes | Individual. |
| Voko | Tribe | Yes | Yes | No | Yes | Individual. |
| Kolbila | Tribe | Yes | Yes | No | Yes | Individual. |

TABLE 32.--Land inheritance among tribes

| Tribe | Women inherit | Male who inherits | Equal inheritance | Sharing with brothers |
|---|---|---|---|---|
| Toupouri | No | Oldest | No | No. |
| Massa | No | Oldest | No | No. |
| Guiziga | No | Oldest | No | Yes. |
| Mandara | No | Oldest | No | No. |
| Kotoko | No | Oldest | No | No. |
| Foulbe | Yes | All | Yes | Yes. |
| Mafa | No | Youngest | No | Yes. |
| Ouldeme | No | All | Yes | Yes. |
| Mafou | No | Oldest | No | Yes. |
| Guidar | No | Oldest | No | Yes. |
| Fali | No | All | No | Yes. |
| Tchevi | No | Oldest | No | Yes. |
| Djimi | No | Oldest | No | Yes. |
| Bana | No | Oldest | Yes | Yes. |
| Kapsiki | No | All | No | Yes. |
| Doayo | No | Oldest | No | Yes. |
| Bata | No | Oldest | Yes | Yes. |
| Tchamba | No | Oldest | No | No. |
| Koma Kadam | No | Youngest | No | No. |
| Voko | No | Oldest | No | Yes. |
| Kolbila | No | Oldest | No | No. |

## Amount of land available for grazing or other use

The amount of land available for grazing or other use varies greatly in different parts of the survey area. The amount can be estimated by subtracting from the total area the amount of land needed for cultivation, villages, roads, and watercourses and other land in nonagricultural use. The amount of land needed for agriculture can be estimated by multiplying the number of inhabitants by the area needed for cultivation to sustain each inhabitant. Estimates of the amount of land available for grazing or other use is shown in table 33.

## The land system--conclusions

Ownership and transfer of land vary not only according to tribal customs but more importantly according to the population density in a given area.

South of the Benoue-Kebi line, land is plentiful, and land ownership presents few problems. In the densely populated area in the north, however, the right to use the land is controlled by rigid systems.

Unused land is rare where the population density is 20 to 30 inhabitants per square kilometer. The problem of population density should be considered in planning projects.

TABLE 33.--Estimates of land available for grazing or other use

| Division | Number of inhabitants | Area | Area cultivated | Other land unavailable for grazing | Available for grazing or other use |
|---|---|---|---|---|---|
| | | $Km^2$ | $Km^2$ | $Km^2$ | $Km^2$ |
| Bogo | 31,728 | 993 | 225 | 198 | 570 |
| Garoua | 59,383 | 13,614 | 636 | 272 | 12,706 |
| Guibi | 28,858 | 958 | 204 | 192 | 562 |
| Guidar | 118,903 | 4,162 | 605 | 832 | 2,725 |
| Kaele | 104,840 | 2,833 | 744 | 566 | 1,523 |
| Kar-Hay | 45,414 | 1,305 | 322 | 260 | 723 |
| Kousseri | 2,475 | 160 | 17 | 32 | 111 |
| Logone-Birni | 21,388 | 4,809 | 152 | 962 | 3,695 |
| Maga | 33,839 | 1,945 | 240 | 388 | 1,317 |
| Makari | 62,586 | 3,666 | 444 | 732 | 2,488 |
| Mandara Mountains | 142,852 | 1,667 | 400 | 498 | 769 |
| Mandara Plateau | 176,637 | 5,462 | 900 | 1,365 | 3,197 |
| Maroua | 109,338 | 3,142 | 776 | 628 | 1,738 |
| Meri | 35,644 | 530 | 253 | 159 | 118 |
| Mindif | 44,890 | 2,200 | 318 | 440 | 1,442 |
| Poli | 29,480 | 5,600 | 612 | 1,120 | 4,068 |
| Tcholire | 53,134 | 32,021 | 440 | 6,404 | 25,617 |
| Yagoua | 47,272 | 1,095 | 335 | 218 | 542 |

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## Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Annual plants. Plants that must reproduce or grow from seed each year.

Available water capacity. The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as centimeters of water per centimeter of soil. The capacity, in centimeters in a 200-centimeter profile or to a limiting layer is expressed as--

| | Centimeters |
|---|---|
| Low | 0 to 10 |
| Moderate | 10 to 25 |
| High | More than 25 |

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles 2 millimeters to 7.5 centimeters in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are--

Loose.--Noncoherent when dry or moist; does not hold together in a mass.

Friable.--When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.--When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.--When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.--When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.--When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.--When dry, breaks into powder or individual grains under very slight pressure.

Cemented.--Hard; little affected by moistening.

Delta. An alluvial deposit, commonly triangular in shape, formed largely beneath water and deposited at the mouth of a river or stream.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.--Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.--Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.--Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.--Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.--Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.--Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.--Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Ecology. The study of the interrelationships of plants and animals within a given set of environmental conditions.

Elevage. The raising of livestock from birth to adulthood.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility status. The relative capacity of a soil to supply the plant nutrients essential to crop production. In this report the ratings of fertility status of soils used for production of rainfed crops are based on the following criteria for cation exchange capacity (CEC) in milliequivalents (me), for percentage of base saturation (BS), and percent of organic matter (OM), and percent of exchangeable sodium.

| Rating | CEC<br>me | BS<br>pct | OM<br>pct |
|---|---|---|---|
| Very high | More than 24 | More than 80 | More than 5 |
| High | 14 to 24 | 50 to 80 | 3 to 5 |
| Medium | 3 to 15 | Less than 50 | Less than 3 |
| Low | More than 15 percent exchangeable sodium. | | |

Flooding. Covering or inundation of soil by water from overflowing of rivers or runoff from adjacent higher soils, expressed in terms of frequency, duration, and period of the year when flooding occurs.

Frequency.--None--No reasonable possibility of flooding.
Rare--Flooding unlikely but possible under abnormal conditions.
Occasional--Flooding likely 1 or 2 times during rainfall season.
Frequent--Flooding likely with every storm cycle of rainfall season.
Continuous--Flooding likely during a major part of rainfall season

Duration.--Very brief--Less than 1 day.
Brief--1 day to 2 days.
Long--2 days to 1 month
Very long--More than 1 month.

Period.--Rainfall season of 3 to 6 months.

Fine textured. (heavy textured) soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Food for animals.

Forb. An herbaceous plant; not a tree, shrub, or grass.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Grazing systems. A specialized system for managing rangeland. It specifies alternate periods of use and nonuse in a planned sequence over a period of years.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The environment in which a population of plants or animals occur.

Herbage. The total vegetative portion of plants.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are--

Border.--Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.--Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.--Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Key species. The species of plant that is most preferred by grazing animals and that generally contributes most to their diet.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance--few, common, and many; size--fine, medium, and coarse; and contrast--faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Natural plant community. A plant community made up of native species of vegetation.

Nutritive elements. Chemical elements essential to life that are found in plants.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Overgrazing. Grazing that removes an excessive amount of the photosynthetic tissue or growing parts of plants and that results in deterioration of the plant community.

Overstory. The canopy or tops of trees and shrubs.

Palatability. The relish with which a particular plant species is consumed by an animal.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Perennial vegetation. Plants that put forth new growth from root crowns or stems and do not have to start growth each year from seed.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of centimeters per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.15), slow (0.15 to 2.0), moderate (2.0 to 12.0), rapid (12.0 to 25.0), and very rapid (more than 25.0).

Phase, soil. A subdivision of a soil unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

Plant community. Species of plants that grow together on a given site.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents that commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on exposure to repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade, whereas ironstone cannot be cut but can be broken or shattered with a spade. Plinthite is one form of the material that has been called laterite.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Potential plant community. The kind and amount of vegetation that would grow on a particular site if man's influence is absent and if resulting plant succession develops to its potential within a specified period.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present production of a range described in terms relative to potential production of the range.

Rangeland. Land on which the native vegetation (climax or natural potential) is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing.

Range site. A distinctive kind of rangeland which, in the absence of abnormal or physical disturbance, has potential for supporting a unique native plant community. Differences among range sites relate to differences in the kind or proportion of species or to differences in total productivity.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as--

| | pH | | pH |
|---|---|---|---|
| Extremely acid | Below 4.5 | Neutral | 6.6 to 7.3 |
| Very strongly acid | 4.5 to 5.0 | Mildly alkaline | 7.4 to 7.8 |
| Strongly acid | 5.1 to 5.5 | Moderately alkaline | 7.9 to 8.4 |
| Medium acid | 5.6 to 6.0 | Strongly alkaline | 8.5 to 9.0 |
| Slightly acid | 6.1 to 6.5 | Very strongly alkaline | 9.1 and higher |

Relief. The elevations or inequalities of a land surface, considered collectively.

Resource conservation plan. A plan that is designed for the use and management of the resources and that will maintain or improve the condition of the resources.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground water runoff or seepage flow from ground water.

Savannah. A natural grassland that can support a scattered stand of trees.

Shrub. Low-growing, woody perennial plant.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The gradient of the soil surface, expressed in a percentage of the difference in vertical elevation for each 100 meters of horizontal distance. Slope is usually expressed in terms of single slopes, except where soil relief is very complex, for example, as in areas of dunes. Descriptive terms for various limits of slope are listed below.

| Percentage of slope | Single slope | Complex slope |
|---|---|---|
| 0 - 1 | Nearly level or level | Nearly level or level |
| 1 - 5 | Gently sloping | Undulating |
| 5 - 9 | Moderately sloping | Gently rolling |
| 9 - 15 | Strongly sloping | Rolling |
| 15 - 30 | Moderately steep | Hilly |
| 30 - 60 | Steep | Steep |
| More than 60 | Very steep | Very steep |

Sodic soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodium status. The amount of exchangeable sodium in a soil, expressed as a percentage obtained by dividing the exchangeable sodium (milli-equivalents per 100 grams) by the exchange capacity. Sodium status is expressed in terms as low (less than 5 percent), moderate (5 to 15 percent), and high (more than 15 percent).

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil depth. The total depth of soil horizons to bedrock or to other layers that restrict plant roots. The classes of soil depth are listed below.

| Class | Soil depth (in centimeters) |
|---|---|
| Very shallow | Less than 25 |
| Shallow | 25 to 50 |
| Moderately deep | 50 to 100 |
| Deep | 100 to 150 |
| Very deep | More than 150 |

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: very coarse sand (2.0 millimeters to 1.0 millimeter); coarse sand (1.0 to 0.5 millimeter); medium sand (0.5 to 0.25 millimeter); fine sand (0.25 to 0.10 millimeter); very fine sand (0.10 to 0.05 millimeter); silt (0.005 to 0.002 millimeter); and clay (less than 0.002 millimeter).

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil or layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Understory vegetation. Plants that grow under a tree or shrub canopy.

Underutilized. Refers to forage that could have been harvested without reducing the plant numbers but that was not grazed.

Unpalatable. Vegetation that is distasteful to livestock. Livestock will not graze a particular species of plant unless forced to.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams emerging from hills or mountains and spreading sediments onto the lowland as a series of adjacent alluvial fans.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Appendix

List of plants

GRASSES

Andropogon africanus
Andropogon amplecteus
Andropogon ascinadis
Andropogon auriculatus
Andropogon brazzae
Andropogon gayanus
Andropogon gayanus galerie
Andropogon schirensis
Andropogon tschaemion
Aristida mutabilis
Brachiaria fulva
Brachiaria mutica
Brachiaria ruziziensts
Brachiaria semiundulata
Cenchrus ciliaris
Cenchrus echinatus
Chloris gayana
Chloris pilosa
Chloris prieuri
Chloris pycnothrix
Chloris robusta
Coelarachis afraurita
Ctenium newtorii
Cymbopogon dentiflorus
Cymbopogon giganteus
Cyperus
Cyperus obtusiflorus
Dactyloctenium aegyptium
Digitaria adscendens
Digitaria exilis
Digitaria gayana
Digitaria lecardii
Digitaria munitiflora
Digitaria pentii
Digitaria ternata
Digitaria valida
Echinochloa colona
Ehrharta calycina
Eleusine indica
Enncopogon brachystachyus
Eragrostis cambissidian
Eragrostis cappillaris
Eragrostis cilianensis
Eragrostis curvula
Eragrostis robusta
Eragrostis tremula
Eriochysis brachypogon
Erivchloa nubica
Euclasta condylatricha
Fuirena glomerata
Hyperrhenia dissoluta
Hyperrhenia filipendula
Hyperrhenia rufa
Hyperrhenia welwitschii
Imperata species
Loudetia arundinacea
Loudetia kagerensis
Loudetia phragmatoides
Melinis minutiflora
Melinis tennuissima
Oryza brachyantha
Oryzopsis miliacoa
Panicum coloratum
Panicum elatum
Panicum exile
Panicum frederic
Panicum maximum coloniao
Panicum phragmitoides
Paspalum auriculata
Paspalum scrobiculatum
Pennisetum mollissimum
Pennisetum parviflorum
Pennisetum pedicellatum
Pennisetum polystachyon
Pennisetum purpureum
Pennisetum setosum
Pennisetum subangustum
Pennisetum typhoides
Hybride P. typhoides X P. purpureum
Rhynchelytrum repens
Rottboellia exaltata
Schizachyrium brevifolium
Scleris vogelii
Setaria anceps
Setaria communis
Setaria megaphylla
Setaria pallidifusca
Setaria sphacelata
Setaria sphacelata anceps
Setaria sphacelata var nandi
Sporobolus granularis
Sporobolus pyramidalis
Urochloa lata

## FORBS

Abannoa imdulata
Callopogonium
Cida rumbifolia
Clitoria ternatea
Datura innoxia
Desmodium uncinatum
Glycine javanica
Nicotiana tabacun
Physalis angulata
Micrargeria filiformis
Solanum cerasiferum
Trichodesma africanum
Phaseolus atropurprueus
Smilax Kraussiana (Smilacaceae)
Stylosanthes gracilis
Tacca involucrata
Vahlia dichotoma (saxifragceae)

## WOODY PLANTS

Acacia raddiana
Acacia senegal
Acacia sieberiana
Albizia coriaria
Albizia zygia
Allophylus africanus
Allophylus cf. grandifolius
Annona arenaria
Anthocleista nobilis
Antidesma venosum
Aubrevillea kerstingii
Balanites aegyptiaca
Bauhinia = Piliostigma
Beilschmiedia species
Bombax buonopozense
Borassus (flabellifer) aethiopum
Bridelia ferruginea
Bridelia ndellensis
Bridelia cf. speciosa
Burkea africana
Butyrospermum paradoxum
Caddaba farinosa
Calotropis procera
Canthium venosum
Carissa edulis
Cassia petersiana
Clausena anisata
Combretum nigricans
Commiphora africana
Commiphora kerstingii
Craterispermum laurinum
Crossopteryx febrifuga
Croton macrostachyus
Cussonia barteri
Daniellia oliveri
Deinbollia
Dombeya cf. multiflora
Ekebergia senegalensis
Entada abyssinica
Entada africana
Eriocoelum kerstingii
Erythrina senegalensis
Erythrina sigmoidea
Eugenia species
Fadogia erythrophloea
Fagara tessmanii
Faurea speciosa
Ficus capensis
Ficus congensis
Ficus glumosa
Ficus glumosa var. glaberrima
Ficus gnaphalocarpa
Ficus ovata
Ficus thonningii
Ficus umbellata
Ficus vallis-choudae
Ficus vogeliana
Flacourtia vogelii
Gardenia ternifolia
(Gymnosporia) Maytenus senegalensis
Harungana madagascariensis
Hymenocardia acida
Hymenodictyon floribundum
Jatropha curcas
Lannea acida
Lannea schimperi
Leea guineensis
Lophira lanceolata
Maesa laneolata
Mangifert indica
Maprounea africana
Maytenus senegalensis

Mitragyna ciliata
Mussaenda arcuata
Mussaenda erythrophylla
Nauclea latifolia
Neoboutonia velutina
Ochna afzelii
Ochna schweinfurthiana
Olax subscorpioidea
Ormocarpum bibracteatum
Oricia suaveolens
Parinari curatellifolia
Parinari kerstingii
Parkia filicoidea
Pavetta lasioclada
Phyllanthus muellerianus
Piliostigma thonningii
Pittosporum vididiflorum
Pithecellobium eriorachis
Polyscias fulva
Protea elliottii var. elliottii
Psidium guajava
Psorospermum febrifugum Spach var. ferrugineum
Psorospermum glaberrimum
Psychotria venosa
Randia malleifera
Ricinus communis
Santaloides afzelii
Sapium ellipticum
Securidaca longipedunculata
Spondianthus preussii var. glaber
Steganataenia araliacea
Sterculia tragacantha
Stereospermum kunthianum
Strychnos spinosa
Swartzia madagascariensis
Syzgium guineense DC. guineense
Syzygium guineense DC. macrocarpum
Terminalia dezevrei
Terminalia glaucescens
Terminalia macroptera
Trchilia roka
Tricalysia okelensis var. oblanceolata
Uapaca togoensis
Uvaria anonoides
Vernonia amygdalania
Vitellaria paradoxa
Vitex doniana
Vitex madiensis
Ximenia americana

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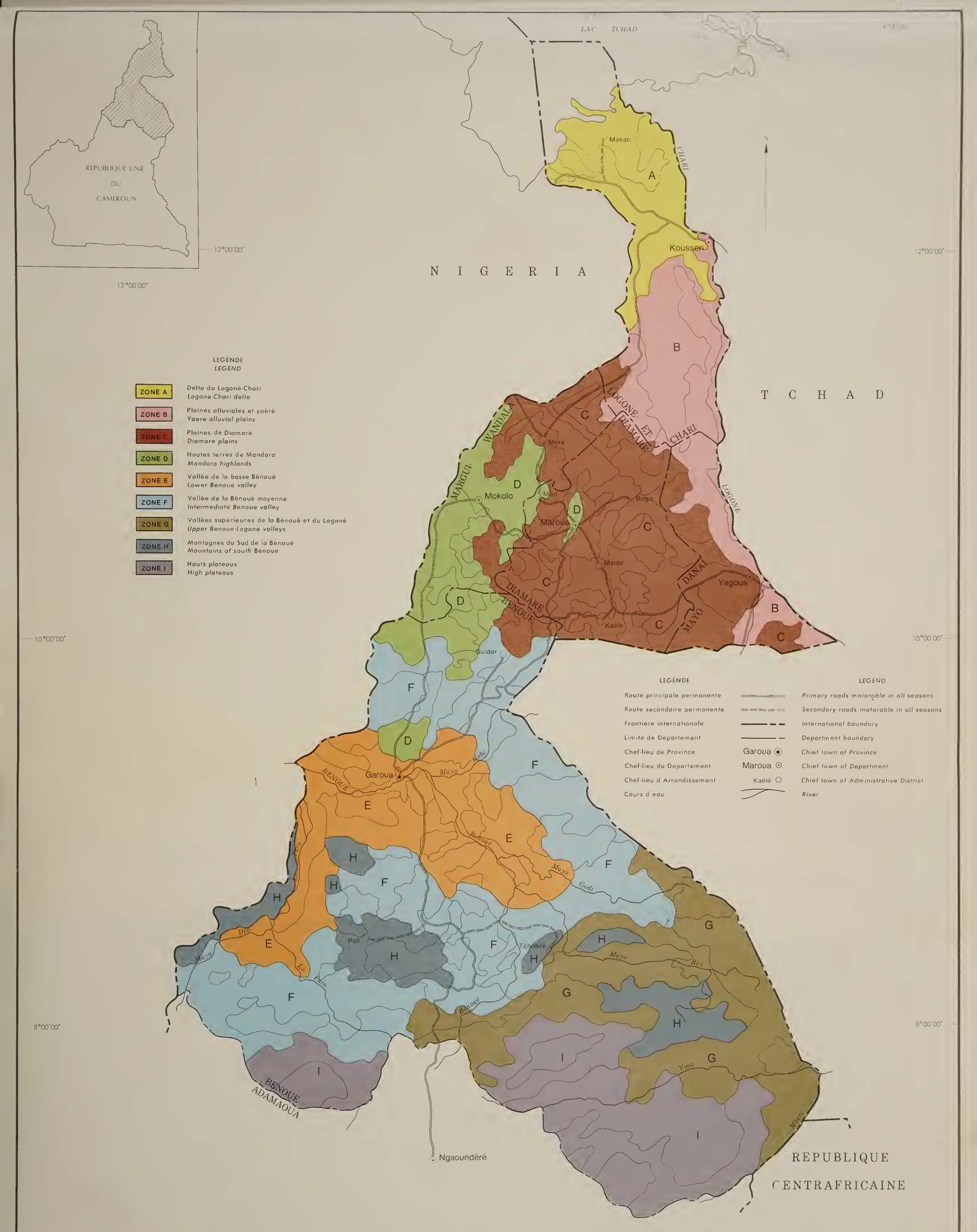


U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

**ZONES DE RESSOURCES**

# NORD DU CAMEROUN

(A L'EXCLUSION DE L'ADAMAOUA DEPARTEMENT)

REGION DU PROJET POUR CONSERVATION ET DEVELOPPEMENT DE RESSOURCES

DEPARTEMENTS DE LA BENOUE, DIAMARE, LOGONE-ET-CHARI, MARGUI-WANDALA, ET MAYO DANAI

REPUBLIQUE UNIE DU CAMEROUN

Echelle 1 2 000 000

25 0 25 50 75 Km

AVRIL 1977

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

***RESOURCE AREAS***

# *NORTH CAMEROON*

*(EXCLUSIVE OF ADAMAOUA DEPARTMENT)*

*RESOURCE CONSERVATION AND DEVELOPMENT PROJECT AREA*

*BENOUE, DIAMARE, LOGONE-ET-CHARI, MARGUI-WANDALA, AND MAYO DANAI DEPARTMENTS*

*UNITED REPUBLIC OF CAMEROON*

*Scale 1 2 000 000*

25 0 25 50 75 M

*APRIL 1977*

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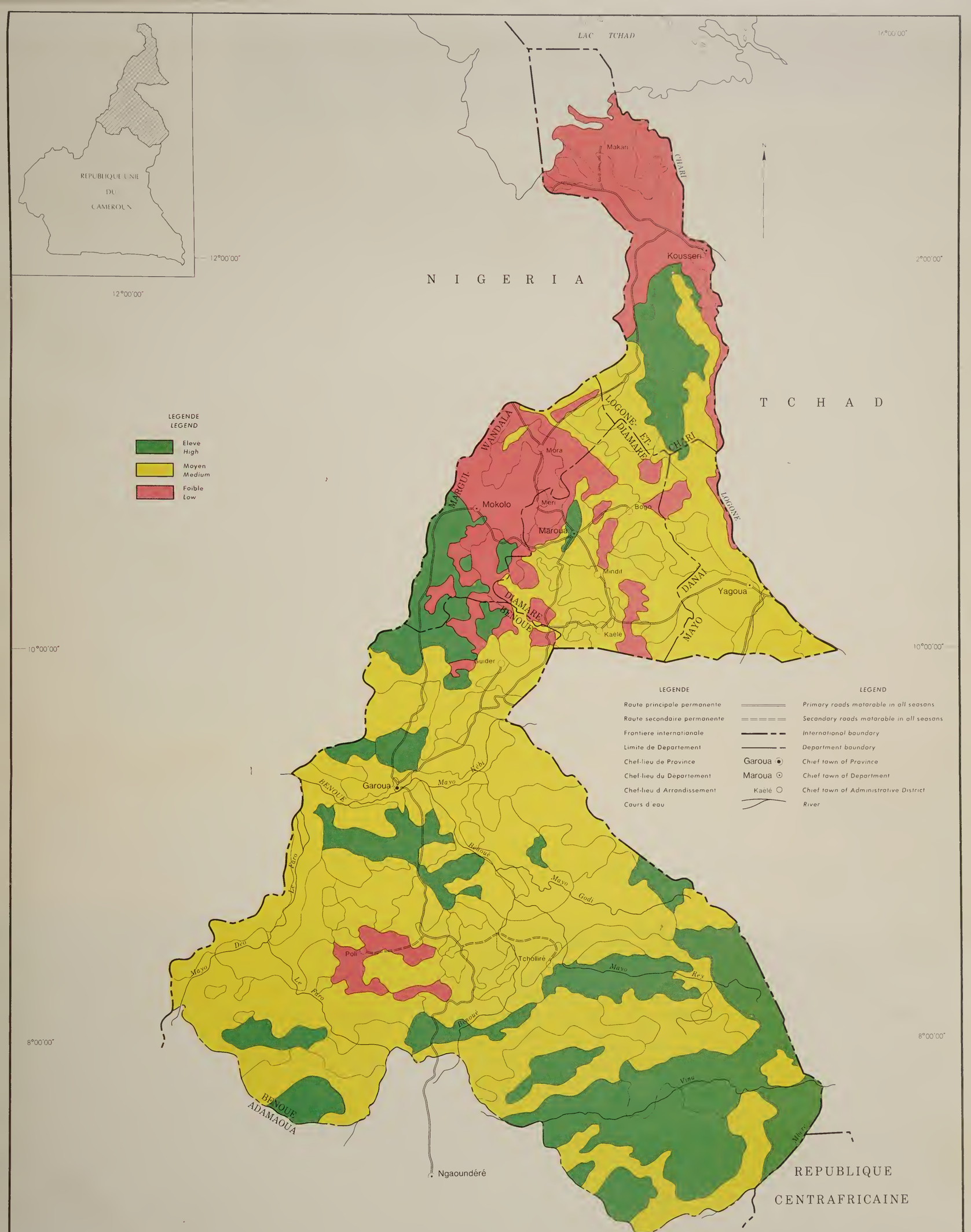
FEVRIER 1972

BASE SOURCE *NATIONAL GEOGRAPHIC INSTITUTE - PARIS*
*CENTRE YAOUNDE 1 500 000 SHEETS*
*FEBRUARY 1972*




U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

**POTENTIEL DE DEVELOPPEMENT DE L'ELEVAGE PAR UNITES DES RESSOURCES**

# NORD DU CAMEROUN

(A L'EXCLUSION DE L'ADAMAOUA DEPARTEMENT)

REGION DU PROJET POUR CONSERVATION ET DEVELOPPEMENT DE RESSOURCES

DEPARTEMENTS DE LA BENOUE, DIAMARE, LOGONE-ET-CHARI, MARGUE-WANDALA, ET MAYO DANAI

REPUBLIQUE UNIE DU CAMEROUN

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AVRIL 1977

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U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

**POTENTIAL FOR LIVESTOCK DEVELOPMENT BY RESOURCE UNITS**

# NORTH CAMEROON

(EXCLUSIVE OF ADAMAOUA DEPARTMENT)

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT AREA

BENOUE DIAMARE LOGONE ET CHARI MARGUE-WANDALA AND MAYO DANAI DEPARTMENTS

UNITED REPUBLIC OF CAMEROON

Scale 1 2 000 000

25 0 25 50 75 M

APRIL 1977

14°00'00"

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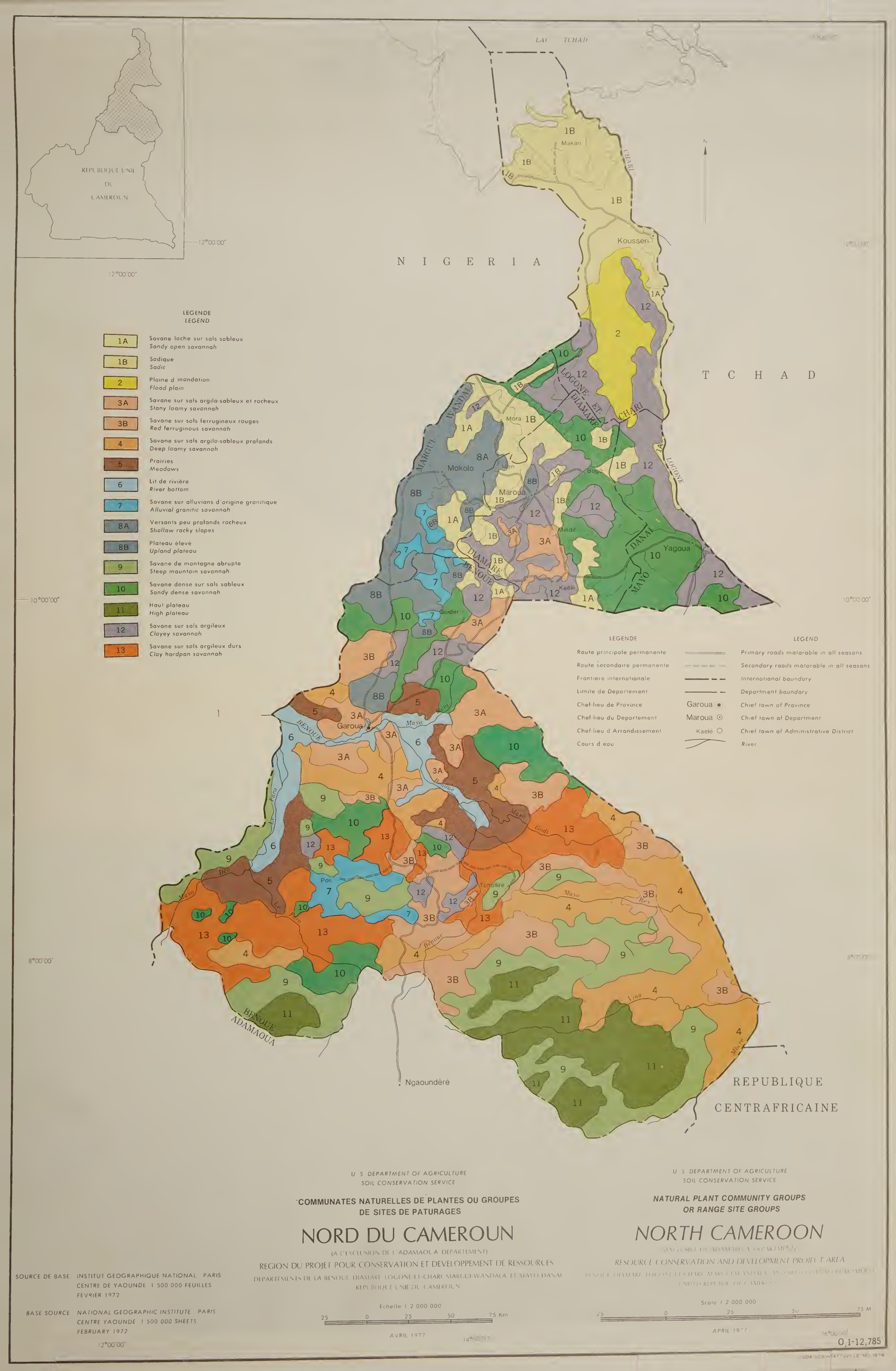


LEGENDE
*LEGEND*

| | |
|---|---|
| 1A | Savane lache sur sols sableux<br>*Sandy open savannah* |
| 1B | Sadique<br>*Sadic* |
| 2 | Plaine d inondation<br>*Flood plain* |
| 3A | Savane sur sols argila-sableux et rocheux<br>*Stony loamy savannah* |
| 3B | Savane sur sols ferrugineux rouges<br>*Red ferruginous savannah* |
| 4 | Savane sur sols argilo-sableux profonds<br>*Deep loamy savannah* |
| 5 | Prairies<br>*Meadows* |
| 6 | Lit de rivière<br>*River bottom* |
| 7 | Savane sur alluvians d'origine granitique<br>*Alluvial granitic savannah* |
| 8A | Versants peu profonds rocheux<br>*Shallow racky slopes* |
| 8B | Plateau élevé<br>*Upland plateau* |
| 9 | Savane de montagne abrupte<br>*Steep mauntain savannah* |
| 10 | Savane dense sur sols sableux<br>*Sandy dense savannah* |
| 11 | Haut plateau<br>*High plateau* |
| 12 | Savane sur sols argileux<br>*Clayey savannah* |
| 13 | Savane sur sols argileux durs<br>*Clay hardpan savannah* |

LEGENDE

| | |
|---|---|
| Route principale permanente | Primary roads matarable in all seasons |
| Route secondaire permanente | Secondary roads matarable in all seasons |
| Frontiere internationale | International boundary |
| Limite de Departement | Department boundary |
| Chef-lieu de Province | Garoua — Chief town of Province |
| Chef-lieu du Departement | Maroua — Chief town of Department |
| Chef-lieu d Arrondissement | Kaele — Chief town of Administrative District |
| Cours d eau | River |

*LEGEND*

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

**COMMUNATES NATURELLES DE PLANTES OU GROUPES DE SITES DE PATURAGES**

# NORD DU CAMEROUN

(A L'EXCLUSION DE L'ADAMAOUA DEPARTEMENT)

REGION DU PROJET POUR CONSERVATION ET DEVELOPPEMENT DE RESSOURCES

DEPARTEMENTS DE LA BENOUE DIAMARE LOGONE-ET-CHARI MARGUI-WANDALA ET MAYO DANAI

REPUBLIQUE UNIE DU CAMEROUN

Echelle 1 2 000 000

25 0 25 50 75 Km

AVRIL 1977

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

***NATURAL PLANT COMMUNITY GROUPS OR RANGE SITE GROUPS***

# *NORTH CAMEROON*

(EXCLUSIVE OF ADAMAOUA DEPARTMENT)

*RESOURCE CONSERVATION AND DEVELOPMENT PROJECT AREA*

BENOUE DIAMARE LOGONE-ET-CHARI MARGUI-WANDALA AND MAYO-DANAI DEPARTMENTS

UNITED REPUBLIC OF CAMEROON

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

# ZONES DE RESSOURCES ET UNITES DE RESSOURCES

# NORD DU CAMEROUN

(A L'EXCLUSION DE L'ADAMAOUA DEPARTEMENT)

REGION DU PROJET POUR CONSERVATION ET DEVELOPPEMENT DE RESSOURCES

DEPARTEMENTS DE LA BENOUE, DIAMARE, LOGONE-ET-CHARI, MARGUI-WANDALA, ET MAYO DANAI

REPUBLIQUE UNIE DU CAMEROUN

Echelle 1. 1 000 000

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U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

# RESOURCE AREAS AND SOIL RESOURCE UNITS

# NORTH CAMEROON

(EXCLUSIVE OF ADAMAOUA DEPARTMENT)

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT AREA

BENOUE, DIAMARE, LOGONE-ET-CHARI, MARGUI-WANDALA, AND MAYO DANAI DEPARTMENTS
UNITED REPUBLIC OF CAMEROON

Scale 1 1 000 000

25 0 25 50 75 M

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LEGENDE
LEGEND

**Zone A** DELTA DU LOGONE CHARI / LOGONE CHARI DELTA

1 Rivages sableux du Lac Tchad / Lake Chad shore deposits
2 Interfluves sodiques et dépressions inondables / Sodic crests and wet depressions

**Zone B** PLAINES ALLUVIALES ET YAERE / YAERE ALLUVIAL PLAINS

3 Grandes plaines d inondation / Wet soils in broad depressions
4 Bourrelet de berge / River levee deposits
5 Plaines a alluvions vertiques / Vertic alluvial plains
6 Effluents et zones d epandages / Floodways and alluvial fans

**Zone C** PLAINES DE DIAMARE / DIAMARE PLAINS

6 Effluents et zones d epandage / Floodways and alluvial fans
7 Sols sodiques / Sodic soils
8 Sols sodiques ou vertiques erodes / Eroded sodic and vertic soils
9 Sols argila sableux sur cuirasse / Loamy soils overlying stonstone layers
10 Terrasses sableuses eoliennes / Low sandy eolian terraces
11 Dunes et depressions interdunaires / Dunes and depressions
12 Sols vertiques en pente faible / Undulating vertic uplands
13 Sols vertiques de plaine / Level vertic lowlands

**Zone D** HAUTES TERRES DE MANDARA / MANDARA HIGHLANDS

14 Depots de sediment / Foot slopes and outwash deposits
15 Sols peu profonds de plateau et pentes fortes de montagne / Shallow plateau soils and steep mountain slopes
16 Montagnes amenagees / Terraced mountain slopes

**Zone E** VALLEE DE LA BASSE BENOUE / LOWER BENOUE VALLEY

17 Sols sableux des zones elevees / Sandy soils on uplands
18 Sols sableux et collines rocheuses / Sandy soils and rocky hills
19 Sols sodiques et vertiques de bas fonds / Sodic and vertic soils at lowlands
20 Depots fluviales / River deposits

**Zone F** VALLEE DE LA BENOUE MOYENNE / INTERMEDIATE BENOUE VALLEY

12 Sols vertiques en pente faible / Undulating vertic uplands
21 Basse terre à horizon argileux d'accumulation / Claypan soils on lowlands
22 Sols peu profonds des hauteurs / Shallow upland soils
23 Collines et vallees / Hill and valley complex
24 Sols sableux profonds a relief faible / Very deep sandy uplands
25 Terrain accidente a sols gravillonnaires / Gravelly soils at sloping uplands

**Zone G** VALLEES SUPERIEURES DE LA BENOUE ET DU LOGONE / UPPER BENOUE LOGONE VALLEYS

23 Collines et vallees / Hill and valley complex
24 Sols sableux profonds a relief faible / Very deep sandy uplands

**Zone H** MONTAGNES DU SUD DE LA BENOUE / MOUNTAINS OF SOUTH BENOUE

14 Depots de sediment / Foot slopes and outwash deposits
26 Terrain montagneux / Steep mountain slopes

**Zone I** HAUTS PLATEAUX / HIGH PLATEAUS

27 Decrochements rocheux des plateaux / Stony steep plateau borders
28 Epaulement des plateaux / Plateau upper slopes
29 Terrain sommitaux des plateaux / Plateau summits

LEGENDE / LEGEND

Route principale permanente — Primary roads matarable in all seasons
Route secandaire permanente — Secandary roads matarable in all seasons
Frantière internatianale — Internatianal baundary
Limite de Départements — Department baundary
Chef-lieu de Pravince — Garoua — Chief tawn af Pravince
Chef-lieu du Département — Maroua — Chief tawn af Department
Chef-lieu d'Arrandissement — Kaélé — Chief tawn af Administrative District
Cours d'eau — River

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